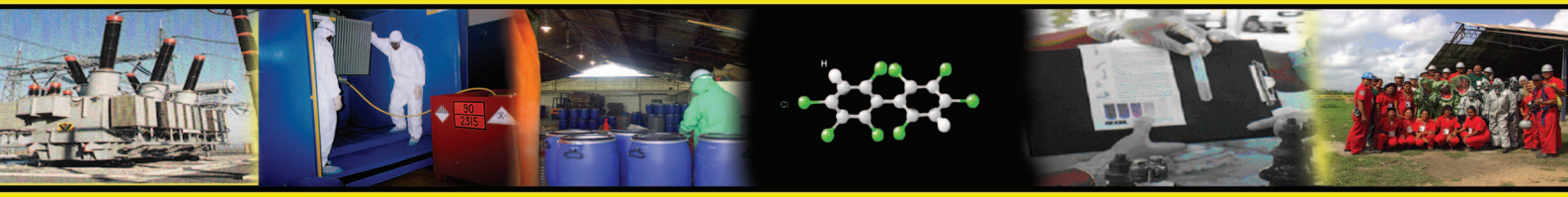
BASEL CONVENTION

UNEP

Preparation of a National Environmentally Sound Management Plan for PCBs and PCB-Contaminated Equipment

Training Manual

Secretariat of the Basel Convention



Training Manual for the preparation of a national Environmentally Sound Management plan for PCBs and PCB-contaminated equipment in the framework of the implementation of the Basel Convention

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Preparation of a national environmentally sound management plan for PCBs and PCB-contaminated equipment in the context of the implementation of the Basel Convention

Training Manual

Basel Convention Series/SBC No. 2003/01

Contents

1 – PCB awareness-raising module

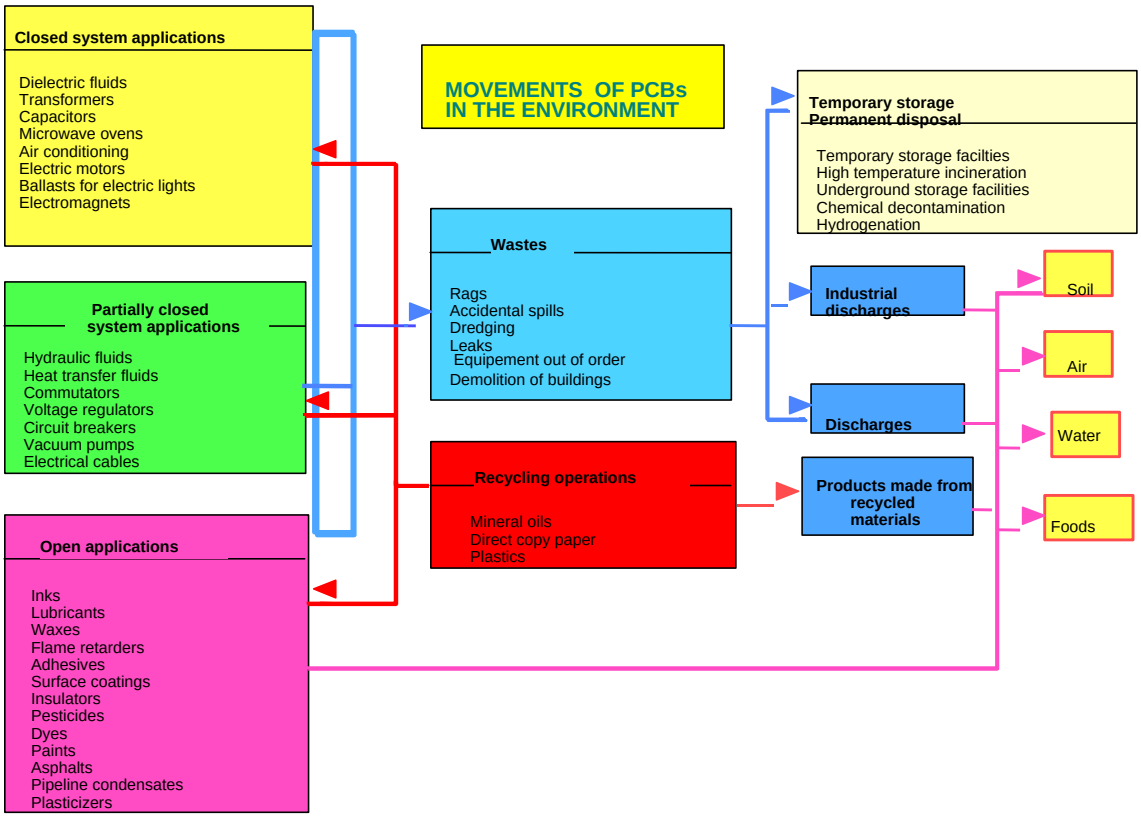
The awareness-raising module contains technical information on PCBs and management related issues during industrial use until their final elimination. Pilot programmes carried out in a number of countries have demonstrated the considerable demand for information by both the public and the private sectors. This module is also designed for the competent authorities and for PCB owners and stresses their responsibility for ensuring the environmentally sound management of PCBs. This demand for information is due to the fact that, historically, the environmental repercussions of the industrial use of PCBs were not taken into account when they were originally placed on the market.

1.1 – History, regulation and definition of PCBs

History and siting of PCBs

PCBs may be considered a historical waste as they have been in industrial use throughout the twentieth century. Even today, PCBs whose production and sale is prohibited continue to be used in operating equipment which has a limited life. This is what gives them the status of a historical waste and sets them apart from other types of waste. As an example, we could cite other historical wastes such as asbestos (chrysotile). PCBs were first identified in the nineteenth century and started being manufactured on an industrial scale in 1929. They were intensively used between 1920 and 1980.

Where PCBs are found



Dielectric fluids in transformers and capacitors	60 %
Industrial and hydraulic fluids, gas turbines	15 %
Adhesives, textiles, printing works and pesticides	25 %
Additives in the preparation of insecticides, bactericides, etc.	ND

The following countries have been the main manufacturers of PCBs:

- Austria, China, Czechoslovakia, France, Germany, Italy, Japan, Russia, Spain, United Kingdom and United States.

In 1994 a European Commission study (DG XI) was carried out on the quantities of PCBs in Europe. This study looked at the distribution of PCBs in each European Community country, with a view to assessing the quantities of PCBs to be destroyed by 2010.
PCB wastes were grouped into 3 categories:

- Pure liquid PCBs or Askarel;
- Solid PCBs;
- PCB-contaminated soil.

The study estimated the total quantity of liquid PCBs at 200,000 tons. These liquid PCBs originate from existing transformers and capacitors, which are still awaiting destruction. France, Germany and Italy head the league of PCB-holding countries, each having in excess of 40,000 tons, while Greece, Ireland and Portugal appear to have the smallest quantities.

The following table shows the quantity of liquid PCBs contained in transformers and capacitors, country by country.

Liquid PCBs		
Country	**Transformers**	**Capacitors**
Belgium	10 000	< 2000
France	45 000	>2500
Germany	30 000	12 000
United Kingdom	3000	<6000
Ireland	100	<250
Spain	22 000	3000
Portugal	2500	500
Italy	45 000	<7000
Greece	2500	500
TOTAL	» 160 000	» 33 000
Total quantity: 200,000 tons		
Total quantity of solids: 400,000 tons		

We provide below a breakdown of national PCB stocks as inventorized by Environment Canada in 1993:

In use	
Liquids in use containing askarel (with exception of ballasts for fluorescent tubes)	11 500 metric tons
Equipment in use containing askarel – weight of voided appliances (in particular transformers and capacitors)	24 905 metric tons
Contaminated mineral oil in use	2 161 metric tons
Transformers in use containing contaminated mineral oil – weight of voided appliances	7 130 metric tons

Stored	
Stored fluids containing askarel	6 265 metric tons
Stored equipment containing askarel (in particular, weight of drained appliances – transformers and capacitors)	8 982 metric tons
Stored contaminated mineral oil	3 787 metric tons
Various stored PCB-containing wastes, of which	• 95 718 tons of earth, • 6 328 tons of ballasts, • 1 582 tons of other voided appliances and 4 364 tons of sundry wastes totalling 107 992 metric tons
Total PCB-containing materials:	**172 722 metric tons**

PCB destruction capacity Europe:

The total quantity of PCBs in Europe measures 160,000 tons, as against an available destruction capacity of 68,000 tons.

Incineration capacity (tons)			
Country	Fluids	Solids	Routes
Belgium	9 000	2 000	Within the country
France	18 300	23 000	
Germany	30 000	20 000	
United Kingdom	11 000	15 000	
Ireland	Nothing	Nothing	UK Mainly to France and UK*
Spain	Potentiality	Potentiality	
Portugal	Nothing	Nothing	
Italy	Nothing	Nothing	
Greece	Potentiality	Potentiality	
TOTAL	» 68 300	» 60 000	
Total capacity: 128 300 tons			

Regulations in force in the industrialized countries:

United States:

- Manufacture and marketing of PCBs prohibited since 1979
- All wastes containing more than 50 ppm of PCBs (50 mg/kg) are considered to be PCBs

Australia:

- Definition of PCB: > 50 ppm
- Concentrated PCB: > 10 % PCBs (100 000 ppm)
- Non-PCB: < 2 ppm
- Removal and destruction of equipment in use

European Union:

1996: Directive 96/59/EC on the destruction of PCBs

- Destruction of all PCBs by 2010
- All wastes containing more that 50 ppm of PCBs (0.5 mg/kg) are considered to be PCBs
- Appliances contaminated to a level between 50 and 500 ppm may be retained until the end of their service life, provided they are identified and labelled

Most widespread uses of PCBs

Two primary uses: prior to 1975, PCBs formed part of the composition of many products. Among their uses were:

- Bonds or plasticizers in varnishes, polishes, paints, inks, glues, copying paper, etc.;
- Also found in various other products, such as insecticides, packaging, lubricating and cutting oils.

These are all *open applications.*

In addition, because of their considerable dielectric potential, their high heat absorption capacity and their fire-resistant properties, they are used as:

- *Dielectric fluids*: fire-resistant liquids in transformers (and, therefore, mixed with chlorobenzenes), in capacitors, switches, etc.;
- *Coolants*, in places where no fire-risk may be tolerated (as in the transport by boat of inflammable products)
- *Hydraulic fluids*: for safety reasons where there are heat considerations (e.g., in certain mining installations).

These are all *closed applications*.

Types of electrical equipment manufactured with PCBs

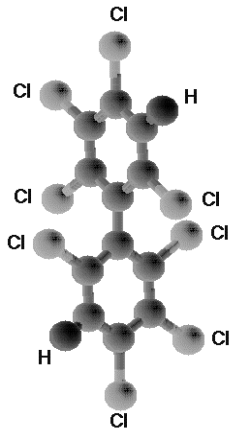
- Transformers insulated with PCBs;
- Capacitors;
- Power switches;

- Distribution units;
- Insulation in very high voltage distribution units.

Physico-chemical properties of PCBs used in electrical equipment

- Differ markedly in terms of their chlorine content;
- PCBs come in the form of viscous liquids or even resins. They are colourless or yellowish and have a distinct smell;
- They are virtually insoluble in water – particularly those with the highest chlorine content – but, by contrast, they are slightly soluble in oil and highly soluble in most organic solvents;
- PCBs are unaffected by light;
- They have remarkable heat stability – which increases with their chlorine content – and only break down at very high temperature (> 1,000 °C);
- PCBs have a high level of chemical inertia and are highly resistant to such chemical agents as acids, bases and oxidizers;
- While not affecting base metals, they dissolve or soften certain rubbers and plastics.

Octa-chloro-biphenyls



Reasons for restricting (in 1975) use of PCBs to closed applications only

The primary disadvantages of PCBs are:

- That they are not biodegradable;
- That, instead, they bioaccumulate.

Since 1966 scientists have noticed that PCBs are virtually indestructible and accumulate in biological chains, thereby damaging the environment and people's health. They are found at all stages of the food chain and studies have revealed their presence, in particular, in the adipous tissue of live species at the end of this chain: fish, seals, birds and, ultimately, humans. The following levels of PCBs have been found in human adipous tissue:

- 1 mg/kg of PCBs in Canada;
- 8 mg/kg in France;
- Up to 10 mg/kg in Germany (study carried out in 1977).

Traces of PCBs have even been detected in mother's milk.

In the light of these observations, it was only logical that PCB use should be restricted to closed applications (with strict arrangements to ensure that there were no accidental releases into nature and to recover, reclaim or destroy used PCBs, as well as the casing of equipment which contained PCBs).

1.2 - Impacts of PCBs on health and the environment

Bio-accumulation of PCBs in the organism

Laboratory experiments on animals have shown that:

- PCBs are easily absorbed through all exposed areas and remain for the most part in fatty tissue, where they tend to accumulate;
- More than 90% of ingested PCBs cross the intestinal walls and are retained in the organism;
- The organ favoured by PCBs is the liver, which stores them (the development of both malign and benign tumours has been observed in mice which have absorbed PCBs and in monkeys, whose sensitivity to these products is closest to that of humans, they cause:

    ⇒ Acne, skin irritations, hyperpigmentation;
    ⇒ Hypersecretion of the tear glands, conjunctivitis;
    ⇒ Liver disorders (hypertrophy et enzymatic changes);
    ⇒ Blood disorders (anaemia et hyperleucytosis);
    ⇒ Reproductive effects: changes in the epidermis (hair loss) and the skin (acne, œdema) are observed among the off-spring of exposed mothers, as well as low birth weight and bone abnormalities.

In mice, the lethal dose 50 at eight days (i.e., the lethal dose for 50% of the population at the end of eight days) is only 0.7 g of PCB per kg of the 'animal.

Actual toxicity of PCBs

PCBs have been the cause of some spectacular poisonings. For instance, in 1968, in Yusho, Japan, some 1,800 people fell ill with an unidentified disease. Thus took the form of rashes, digestive and eye disorders, and numbness of the limbs. It took more than six months before it was realized that this disease, which had already caused several deaths, was in fact a case of serious mass poisoning caused by the consumption of PCB-contaminated rice oil. The PCBs had leaked from a compressor and were present in a concentration of 2,000 ppm (ppm = part per million; 2,000 ppm = 2 per thousand or 0.2%).

In 1979, following a comparable accident, 2,000 people were poisoned in Yu-Chen, Taiwan.

Poisoning of humans:
Studies of cases of poisoning caused by accidental absorption of doses measuring 800-1,000 mg/kg of PCB show that the first areas to show symptoms are the skin (acne, hyper-pigmentation, keratosis, hypersudation) and the eyes (œdema of the eyelids, watering of the eyes).

More general symptoms (fatigue, anorexia, weight-loss), liver disorders, bronchitis, certain peripheral neuropathies and endocrine disruptions complete the clinical picture. These symptoms recede after about a year.

Anomalies have been observed in the children of women who, during pregnancy, have consumed PCB-contaminated oil. These anomalies are primarily found on the skin, in mucous membrane and the epidermis.

Occupational exposure can cause irritations of the skin and the mucous membrane (eyes and respiratory system), chloracne and, with stronger concentrations, liver disorders.

Carcinogenicity of PCBs

Epidemiological studies have shown no significant increase in the incidence of cancer among people exposed to PCBs. Skin, digestive and liver tumours, and also instances of leukaemia, have been attested, however, but scientific analyses have failed to establish a link between increased skin and pancreatic cancer rates and occupational exposure of the victims to PCBs.

The International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), measures the carcinogenic risk of various chemicals and places them in two groups:

- Those which are “carcinogenic to humans” (group 1);
- Those which are “probably carcinogenic to humans” (group 2).

The latter group is further subdivided into groups A and B:

- For group 2 A, evidence of carcinogenicity is “fairly well established”;
- For group 2 B, evidence is “less well established”.

PCBs are categorized in group 2 B.

Exposure threshold values

In the United States, the threshold limit values for exposure to PCBs in the atmosphere of the workplace have been set by the American Conference of Governmental Industrial Hygienists (ACGIH) at:

- 1 mg/m^3 for those with 42% chlorine content;
- 0.5 mg/m^3 for those with 54% chlorine content.

Another agency, the National Institute for Occupational Safety and Health (NIOSH), recommends a much lower limit value:

- 0.01 mg/m^3, to take due account of potential cancer risks.

In Sweden, the limit values have been set at:

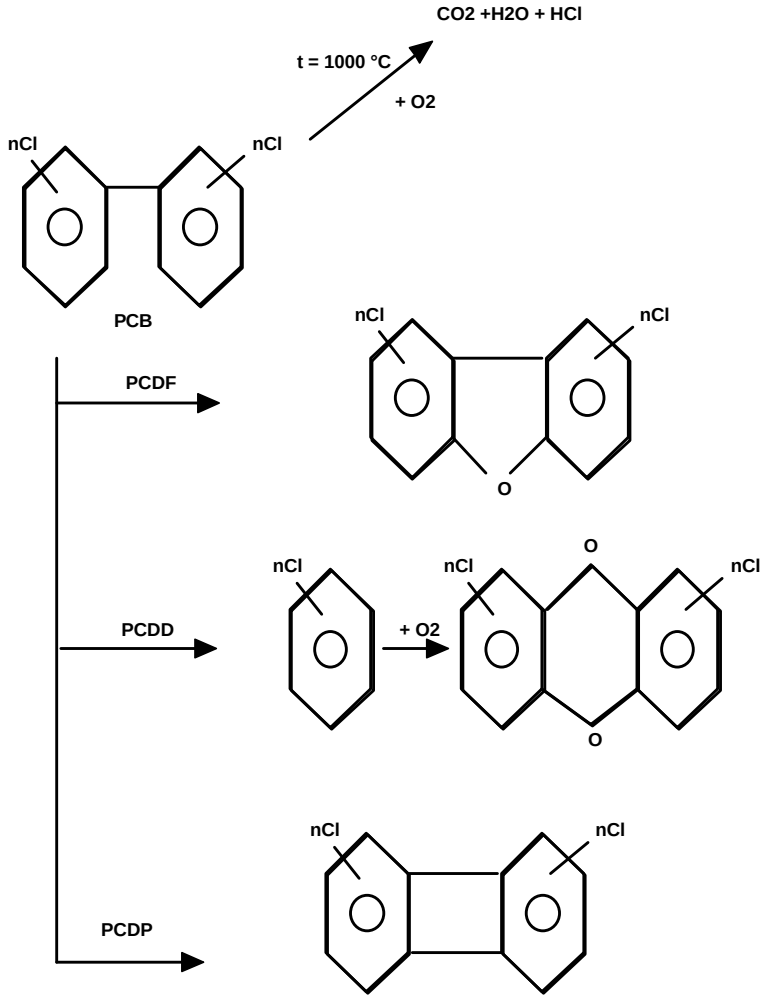
- 0.01 mg/m^3.

Toxicity of products resulting from the breakdown of PCBs

When PCBs are broken down by heat, they produce – first and foremost – chlorine, hydrochloric gas and carbon monoxide. Hydrochloric gas vapours can cause serious irritation of the respiratory tracts, exposed skin areas, the mucous membrane (particularly of the eyes), resulting in pharyngitis, laryngitis, bronchitis and inflammation of the eyes. In strong concentrations there

is a risk of acute pulmonary oedema. Therefore, a transformer which has been damaged should never be sniffed. In the event of fire or decomposition, PCBs also produce, where oxygen is present, small quantities of toxic compounds which belong to the family of furans and dioxins.

⇒ polychlorinated dibenzofurans (PCDFs);
⇒ polychlorinated dibenzodioxins (PCDDs);
⇒ polychlorinated diphenyls (PCDPs).



The precise identification of these products of decomposition is the subject of some debate: they are actually divided up into a number of isomers – 212 in all – which are hard to distinguish and the most toxic of which are the tetrachloride derivatives 2.3.7.8 TCDF and 2.3.7.8 TCDD.

Reasons for the use of PCB appliances

It has long been thought that PCB-based electrical transformers represented a considerable step forward from oil transformers, with their attendant fire hazard. Companies insuring against fire and electrical accident risks granted discounts of up to 10 per cent of the rates charged for oil transformers.

Furthermore, regulations covering public and high-rise buildings prohibited the use of inflammable dielectrics such as oils. At the same time, as the restrictions on the installation of PCB-insulated transformers were less rigorous than those imposed on apparatus insulated with

mineral oils, it was cheaper to use PCB-insulated transformers, even though the PCBs themselves cost 25% more than the mineral oils:

- No need for fire protection: PCBs are non-inflammable – the fitting of firewalls and fire extinguisher systems is not necessary;
- Reduction in the price of electrical cables and reduced mains electricity losses, since PCB transformers can be fitted much closer to the use area, meaning that the low tension cables do not need to be so long;
- Virtually no need for transformer maintenance as there is no periodic regeneration of dielectrics.

PCB accidents

These can be grouped in three main categories:

- *Accidents involving purely mechanical defects* in the electrical equipment, leading to a break in the seal and leakage of PCBs from the casing, but without affecting the composition of the dielectrics. Leaks come, for example, from the seal between the tank and its cover and from rusty spots on the transformer's cooling fan.

  This type of accident results in the dispersion of PCBs, possibly over a wide area if the apparatus has no retention system. It can occur with installed apparatus or when apparatus is being transported. (e.g., when apparatus is being sent for destruction). Experience shows that PCB contamination swiftly penetrates the soil and, in some cases, can even reach the underground waters. The quantities involved are in the order of tens or hundreds of kilograms. This is what is meant by "cold pollution".

- *Simple electrical accidents* which result from electrical disorders caused by voltage surges and insulation defects. The resulting electrical arc leads to the release of hydrochloric gas and a build-up of pressure which causes the envelope to split and dielectrics to leak as liquid or as spray.

  The resulting dispersion of PCBs, more vigorous than in accidents of the first group, and the formation of sprays cause contamination by emission. Considerable quantities of hydrochloric acid may be formed and may even cause problems to emergency services. As the PCBs break down in the absence of air, experts believe that there is little probability of dioxins and furans forming.

  Where environmental protection is concerned, this type of accident is essentially of interest because of the presence of PCBs. Accordingly this is a case of a "cold accident"

- *Accidents involving fire or the decomposition of PCBs in heat and in the presence of air*. The heat-based decomposition of PCBs in the presence of oxygen could cause PCDFs, PCDDs and PCDPs[1]. Analyses of accidents abroad show a furan content considerably higher than that of dioxins (by a factor of almost 100).

  It should also be pointed out that the presence of the most toxic dioxin (2.3.7.8 TCDD) has never been attested at detectable volumes, except in Binghamton (United States of America). In accidents of this type, the dispersion of smoke and soot cause the contamination to spread widely. Thus, in the recorded accidents, all the buildings concerned appear to have been

[1] See annex X

contaminated at very different levels. The length of time the electrical fault lasted (the usual presumed cause of accidents) seems to play an important role. Finally, there also appears to be a correlation between the content of PCBs and PCDFs, with decomposition yields of 1%. In accidents of this latter type, the term “hot pollution” is used.

Causes of a hot accident on a transformer

There are several possible causes of such accidents:

- A voltage surge of atmospheric origin can cause arcing inside the transformer which would normally be suppressed by the primary protection devices;
- A secondary voltage overload or a short-circuit in the main circuits could lead to significant overheating and cause a fire (which, apparently, is what happened in Reims in January 1985). These overloads should normally be picked up, however, and suppressed by upstream protection devices, provided these have been fitted and adjusted in the prescribed manner.
  The phenomena can be aggravated in the event of the mains power being automatically switched back on, if the apparatus is not fitted with a primary protection device;
- Finally, the transformer can be damaged by a fire from another source.

Examples of PCB accidents around the world

The best known of the 40 or so which have been recorded around the world are those of Binghampton and Reims, which starkly demonstrated the risks of pyrolysis contamination caused by the use of PCB dielectrics.

Binghampton

In February 1981, in Binghampton, New York State, a fire swept through an 18-floor building – the State Office Building – following a simple short-circuit in a circuit-breaker, which caused the pyrolysis of a portion of 400 litres of PCBs held in a transformer vat. The smoke generated by the fire was dispersed through the building’s ventilation system so that the entire building was contaminated and had to be evacuated. Analyses showed PCB levels of 100,000-200,000 ppm.

- 2,000 ppm of dibenzofurans, including 2.3.7.8 TCDF.
- 10-20 ppm of dioxins, including 2.3.7.8 TCDD, the Seveso poison.

Access to the building was prohibited except in sealed protective clothing and masks, and the decontamination exercise, which lasted four years, cost US$ 30 million.

Reims

On 14 January 1985, an EDF 250 kVA transformer, insulated with PCBs, exploded in the basement of a six-floor block of flats, in Reims. Because of the extreme cold (-24° C), the transformer was operating under excessive strain and was being drawn on to an estimated load of 360 kVA. The fire resulting from the explosion was swiftly brought under control by the fire service, but the thick black smoke spread up the stairwell, the waste disposal chute and the ventilation ducts to all the floors, necessitating the evacuation of the building. Several days later, the formation of certain contaminants was noted and only a highly specialized laboratory was able to identify these, because of the very low toxicity thresholds.

1.3 - Current development of technology and regulations

Main provisions of European directive of l October 1985

Example from directive 85/467/EEC of the Council of the European Communities:

- From 1 July 1986 the placing on the market (including the second-hand market) of such PCT or PCT-impregnated equipment, capacitors, inductors, etc., is prohibited;
- From 1 July 1986 the use of PCBs and PCTs heat-transmitting fluids in new in closed-circuit heat-transfer installations or as hydraulic fluids, for new underground mining equipment, is prohibited.
- Defines as PCBs (or PCTs) all preparations with a PCB or PCT content higher than 0.01% (100 parts per million) by weight;
- The use of equipment, plant and fluids which were in service on 30 June 1986 continued to be authorized, however, until they were disposed of or reached the end of their service life.

Regulations

The regulations in force generally apply the following procedures:

Obligation to make declarations

- Equipment: Owners of transformers, capacitors, etc., which have been insulated with PCBs must declare this equipment;
- Accidents: Obligation to declare any accidents to the classified installations inspectorate (or equivalent authority);
- Verification: Inspections necessary to establish whether or not installations conform with the regulations;
- Retrofitting: Moving installation to another site. This requires a new declaration. The new site is considered as a new installation.

Instruments governing transport of PCBs

PCBs have long been classified with aromatic halogenated compounds and, as such, have been subject to the regulations governing this family of products. In the absence of any instructions specific to PCBs, the following instruments apply:

Inland transport

- Regulations covering the transport of dangerous goods by rail, road or inland navigation vessels;
- Regulations covering the transport and handling of dangerous goods in maritime ports;
- Regulations covering the transport by air of dangerous goods;
- Regulations covering the transport by sea of dangerous goods; under the IMCO code.

International rail transport
Stipulations of the Bern Convention (RID).

International road transport
Stipulations of annexes A and B of ADR.

How to know whether or not a transformer contains PCBs

Normally, the properties of the dielectrics are stated on the appliance's identification plate. As a rule, since 1975, PCB-impregnated appliances are very clearly labelled, in indelible print on a yellow background.

But if the equipment was installed before 1975, it may not have any labels. If there is no other clear indication, PCBs can be identified by their colourless or yellowish appearance, their characteristic smell and their density of about 1.5, as against 0.85-0.9 for oils: they can be identified by a density test. Failing this, there are other methods for screening PCBs.

Essential aims of regulations covering equipment still in operation

These regulations are designed, above all, to ensure better safety in accordance with the following four principles:

- Protection against environmental spills and the fitting of appropriate retention devices;
- Protection of equipment against the danger of internal electrical faults which may cause an accident or a fire;
- Protection against external fire risks to which the equipment might be exposed;
- Special precautionary measures to be taken during on-the-spot maintenance, regeneration or repair of the equipment.

PCB substitutes

Although the purpose of the new regulations is eventually to eliminate totally the use of PCBs, it is still preferable not to rush into a systematic and a priori conversion of all PCB-containing equipment. On the one hand, this operation poses the problem of the removal and destruction, at one time, of all the existing equipment and, on the other, that of replacing this equipment with other, equally reliable, appliances. When the state of an appliance or its dielectrics necessitates its replacement, two possibilities may be considered:

- Changing the liquid ("retrofilling");
- Installing a new appliance.

Changing the liquid

This involves draining the PCB-based liquid and then decontaminating the appliance and refilling it with another dielectric. The substitute must be totally compatible with the type of appliance and all the materials used in its manufacture.

Among the dielectrics currently being suggested for this purpose, mineral oils are the easiest to use. In all cases, the choice must only be made after a careful comparative study of the risks and after consulting the equipment's manufacturer.

Changing the liquid is a delicate operation, presenting the risk of PCBs escaping into the environment. For that reason it must only be carried out by duly authorized companies.

If the decontamination process cannot guarantee that the new liquid will have a PCB content below 0.05 ppm throughout its service life, because – among other reasons – of the impregnation of the components by PCBs, the appliance must be subject to the same regulatory restrictions as those containing PCB-based liquids, namely, labelling, prevention measures, elimination. The

labelling prescribed by the regulations should include the trade name and the properties of the new liquid and it would also be advisable to give the date on which it started operating with the substitute liquid.

PCB wastes subject to mandatory treatment

The following are to be considered as wastes subject to mandatory treatment in a properly authorized facility which is capable of destroying molecules:

- Scrapped appliances containing or having contained PCBs;
- Mineral oil transformers containing PCBs (> 50 ppm);
- Non reusable PCBs;
- Unusable receptacles which have contained PCBs;
- Clothing, rags, special overalls, gloves, goggles, etc., soiled with PCBs;
- Washing liquids and water containing more than 0.5 microgram/litre of PCBs;
- Earth, rubble and other absorbent products containing (before any dilution) more than 50 ppm of PCBs;
- Transformer cleaning solvents;
- Filtering sand used for dielectric fluids.

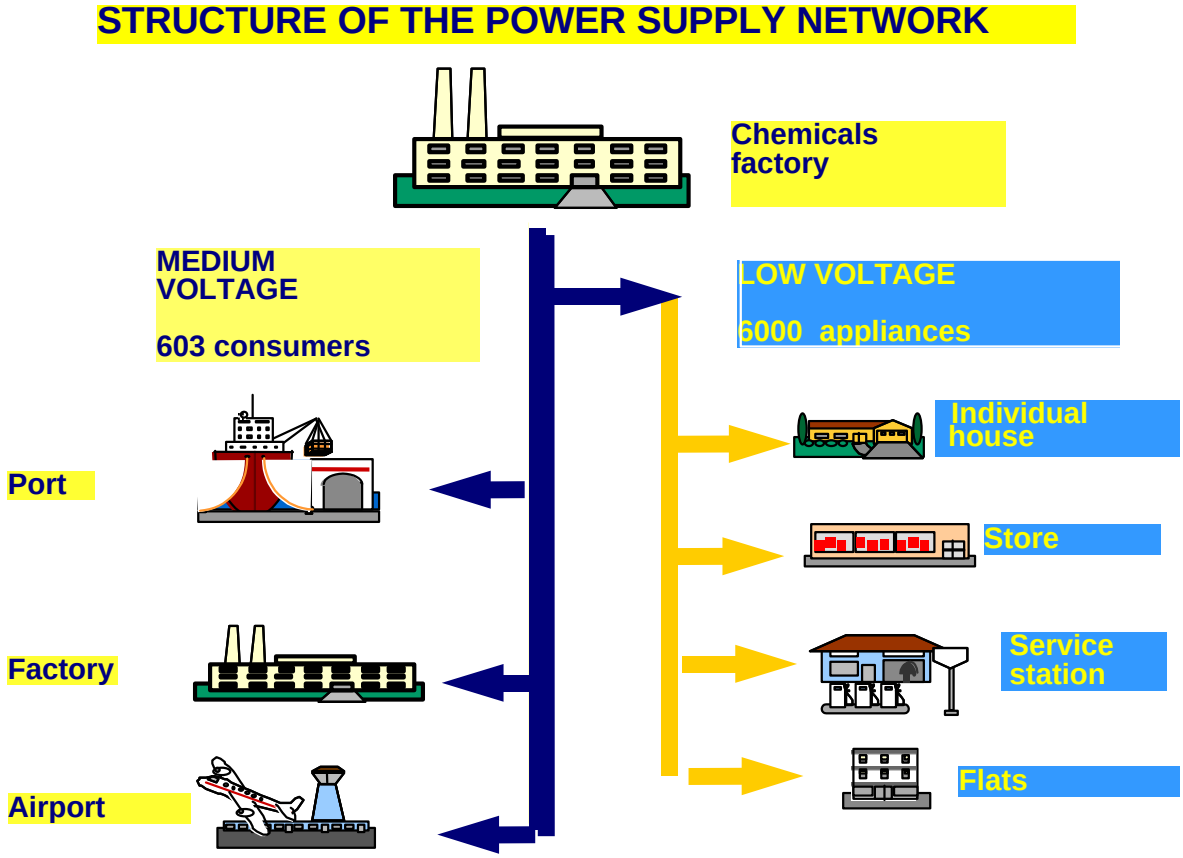
Note: Sand with a PCB content of between 10 and 50 ppm is generally disposed of in approved industrial waste landfills or kept in confinement storage.

1.4 - PCBs in the generation and distribution of electricity

Mains electricity

It is generally reckoned that 60% of operative transformers in the non-industrialized countries are managed by the public electricity network. The owners of private transformers are, as a rule, industries with an installed capacity of some 200-300 kVA. For lower capacities, the industry is connected directly to the low voltage network. The mains electricity supply is divided up as follows:

Very high voltage lines: 400 000 volts	400 000 volts	Long distance and international transport of electrical power
High voltage lines	90 000 volts	Transport of electrical power for heavy industry
High voltage lines	63 000 volts	Railways
Medium voltage	30 000 volts	Transport of electrical power for local industries, small and medium enterprises, services,
Low voltage	380 volts, 230 volts	Electricity supply to households and workshops



Reasons for use of high voltage

The mains network consists of metal cables, which are imperfect conductors of electricity. When very powerful electrical currents pass along these cables, a portion of the energy being transported is transformed into heat by the joule effect and lost. To limit such electricity losses, the intensity of the current must be reduced and, by corollary, the voltage at the terminals of the line must be increased. Lowering the intensity of the current means that lighter-weight cables can be used and the line's construction costs may be reduced. Lighter cables can be supported by lighter pylons, with less visual impact on the environment. Transformers are used to increase the voltage at the power-station outlets, while other transformers, situated near the area where the electricity is to be used, lower this voltage.

Electrical transformers

The function of transformers ("voltage raisers") is:

- To raise the voltage at the power-station outlet;
- Or to lower the voltage. In the vicinity of the area where the electricity is to be used, the voltage is gradually lowered to obtain low voltages (230 volts or 380 volts): this being the function of voltage-lowering transformers.

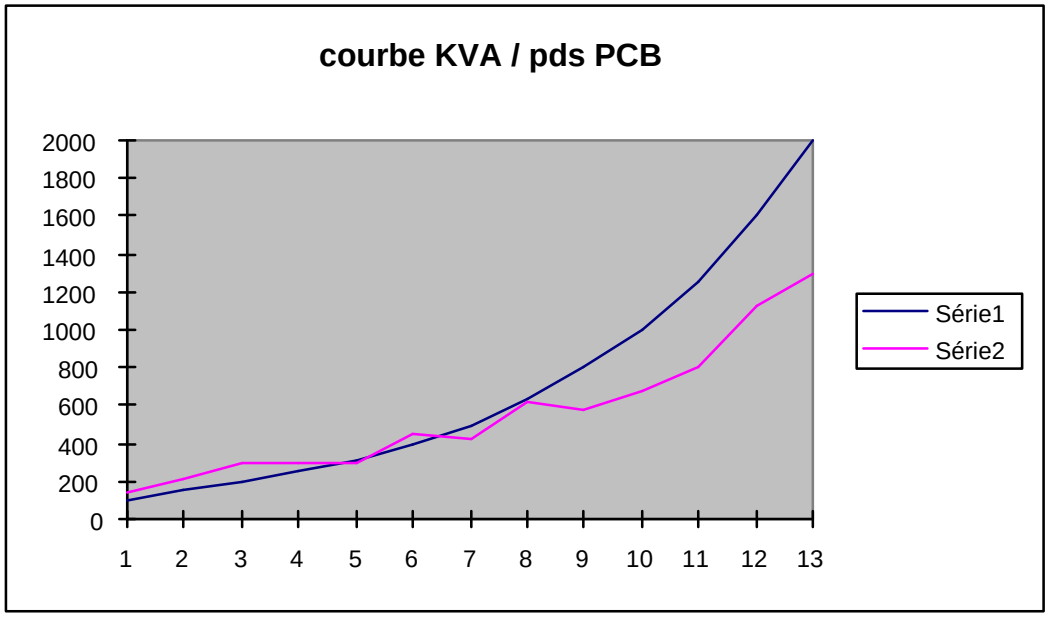
The quantities of dielectric contained in the transformers is directly dependant on the transformer's capacity. The following rule can be applied to estimate this quantity of electricity:

1 kVA = 1 litre of dielectric
1 litre of dielectric = 1.5 kg

A 100 kVA transformer will therefore contain:
100 kVA x 1 l x 1.5 kg = 150 kg
Generally speaking, the quantities stated on the transformer's specification cards are expressed in mass rather than volume. It should also be borne in mind that this formula is not linear. The weight curve climbs less slowly than that of capacity (see the table below):

Quantities of dielectric

CAPACITY OF THE TRANSFORMER	QUANTITY (kg)	VOLUME (Density: 1.56)
100	140	90
160	215	138
200	295	189
250	295	189
315	300	192
400	450	288
500	425	272
630	615	394
800	575	369
1 000	670	430
1 250	800	513
1 600	1 130	724
2 000	1 300	833



Series 1: capacity curve
Series 2: weight curve

Distribution of materials in a transformer

The magnetic circuit is totally immersed in the dielectric. After 20 and more years of use, all the porous materials in the magnetic circuit are impregnated with dielectric. These porous materials include the following:

- The wooden chocks, which absorb 50% of their own weight (thus, a block weighing 10 kg can absorb up to 5 kg of dielectric);
- Insulating cardboard and paper;
- Resins coating the copper wires.

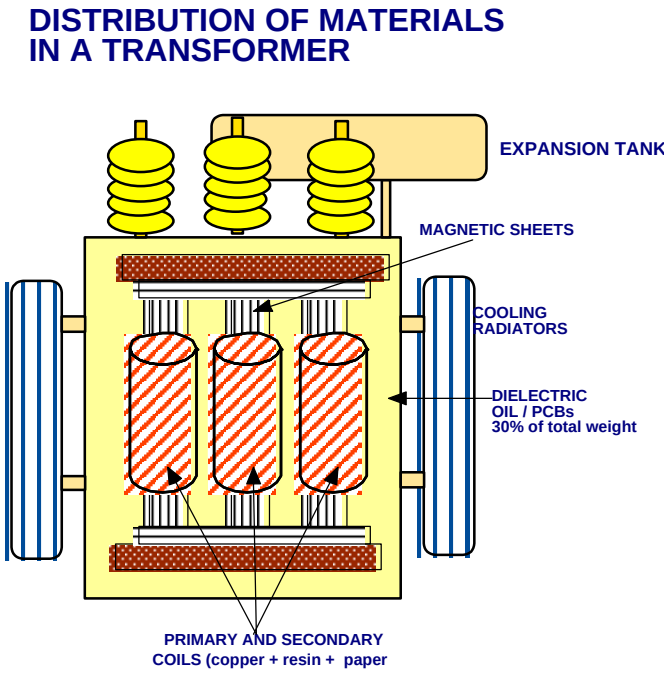
Statistics compiled on the decontamination of transformers show that 5% of the initial PCB content on manufacture is impregnated into the transformer's porous components. Thus, a transformer with a total weight of 1,500 kg is made up of:

10 %:	150 kg of tank (metal mass)
60 %:	900 kg of magnetic circuit
30 %:	450 kg of dielectrics

of which 5% of the dielectrics are impregnated in the magnetic circuit – 5% of 450 kg, or 22.5 kg of PCBs. If this quantity is presented as a ratio of the dielectric mass in a PCB transformer, the PCB constitute a weight ratio of 22.5 kg / 900 kg, or a contamination level of 25,000 ppm.

Given that the maximum level allowed is 50 ppm, this is 500 times higher than the norm. Accordingly, the entire metal parts should be considered as PCB wastes and should be destroyed on the basis as the PCBs themselves.

The procedure for the destruction of these metal parts consists in decontaminating them – i.e., extracting the PCBs contained in their metallic and porous components.

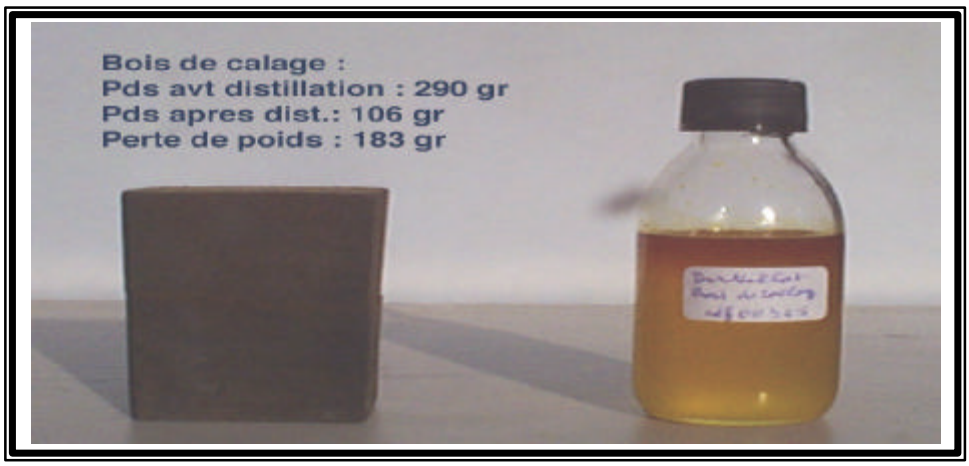


Mineral oil transformers

It should be noted that mineral oil transformers can be contaminated by PCBs. This contamination has two causes:

1 – Using PCBs to top up the oil in appliances. Because of their technical advantages and the ease with which they mix with mineral oils, PCBs have actually been used as a supplement to dielectrics. PCB detection tests carried out in various countries on the transformers of electricity supply networks when those being scrapped have shown contamination (> 50 ppm) levels of the order of 30-40% of the surveyed equipment. The dielectric of these transformers is therefore considered as a PCB waste and should be incinerated in a PCB-approved facility.

2 – Retrofilling of PCB transformers with mineral oil. This operation consists in draining the transformer of its dielectric and refilling if with PCBs. Given the impregnation potential of PCBs, particularly in the porous parts of the transformer, i.e., the wood of the chocking blocks, the cardboard and the resins, these impregnated PCBs gradually leach back into the replacement mineral oil. The photograph below shows, left, a wooden chock and, right, the quantity of PCBs extracted by vacuum suction.



A wooden chock can contain up to 70% of its own weight in PCBs. The leaching back of these PCBs can continue for up to three years before stabilizing. As an example, a 630 kVA transformer which may contain 20 kg of wooden chocking blocks, will, over time, release 70% of its weight, i.e., some 14 kg, as PCBs which leach back. This explains the PCB contamination in retrofilled transformers at concentration levels which can be as high as 10,000 ppm, or 6 kg of PCB to every 600 kg of dielectrics.

Installation of a new appliance

The choice of an appliance involves a number of criteria, including:

- Likelihood that the appliance will cause fire in the event of a fault;
- Behaviour of the appliance in a fire which originates from a source other than the appliance itself;
- Toxicity to humans and the environment of the insulating materials;
- Toxicity, corrosiveness and opacity of the smoke released in the event of a fire;
- Cost of the appliance and its installation;
- Congestion;
- Noise;
- Possibility of its destruction, etc.

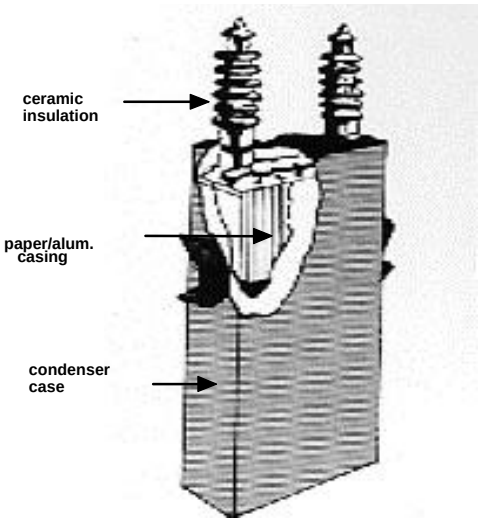
An exhaustive discussion of all the possible approaches lies beyond the scope of this manual. Furthermore, the data gathered on the various replacement products raise a number of questions and, in some cases, require a more detailed knowledge of the appliances and their component parts.

A table summarizing the main advantages and disadvantages of replacement is provided below. There is no all-purpose solution to the problem of replacing PCB-based transformers. Each user must select, from among the products on the market, the one which best meets the specific requirements in hand.

Type of dielectric	Disadvantages	Advantages	Comments
Mineral oils	Fire hazard	Only slightly toxic and well-known liquid Cheapest of the liquid dielectrics	Need to have a disposal pit or similar system
Heavy oils	• Higher viscosity, necessitating special arrangements for cooling the transformer • Dielectric rigidity less than with normal oils	Mineral oil	Need to have a disposal pit or similar system Not widely available on market
Silicon oils	• Unsatisfactory operation in fire • Relatively high coefficient of expansion, necessitating a special tank • High viscosity • Decomposition produces noxious substances (presence of silica) • Must be protected from humidity • Non biodegradable	Non-toxic liquid	Need to have a disposal pit or similar system
Impregnated transformers	• High price, depending on type of insulation • Behaviour in fire varies depending on technical specifications • Very sensitive to pollution and humidity • Needs an outer casing • Noise level may be on the high side	• Non-pollutant • Low quantity of combustible products in the event of fire • Possibility of rapid cooling	More bulky than a liquid dielectric transformer
Encased transformers	• High price • Decomposition may produce toxic substances (applies to certain resins laden with amino-products) • Noise level may be high	• Non-pollutant • Very good resistance to humidity and to pollution • Possibility of rapid cooling	Need to verify performance under overload conditions Need to conduct reaction tests Bulkier than liquid dielectric transformer
Esters	Good dielectric properties Risk of attacking aluminium on coils Need to protect from humidity	Not easily inflammable Non-irritant	Subject to same rules as mineral oil
NF formula	Not compatible with aluminium and zinc	Non-inflammable Good dielectric properties	Halocarbonated liquid

Capacitors containing PCBs

The size of these capacitors varies a great deal, from that of an ice-cube to that of a refrigerator. They can often de identified by the letters “kvar” on their identification plate. These letters show the electrical classification of the capacitor, which usually lies between 5 and 200 kVar. In practice, all capacitors manufactured between 1930 and 1977 as substitutes for dielectric liquid contain PCBs.



Purpose of capacitors

- To provide the starting torque for single-phase motors;
- To guard against voltage surges in electric and electronic equipment;
- To ensure more efficient operation of AC induction motors and boilers;
- To control power line voltage;
- To place in the ballasts of fluorescent or high-intensity lights.

PCB-containing light ballasts

The light ballast ensures that the correct voltage is supplied for the operation of a fluorescent light. The PCB-containing capacitors in these ballasts are usually encased in an asphalt compound placed in a steel case inside the fluorescent light. These capacitors have two electric terminals at the end of a hermetically sealed metal case. A conventional capacitor used in an office fluorescent light contains about 25 grams of PCB. The PCB capacitors used in high-intensity lights contain between 91 and 386 grams of PCB. Since 1978 these fluorescent lamp ballasts have been manufactured without PCBs.

2 – PCB inventory methods

2.1 – Applying inventory modalities and resources

PCBs have been used in two different applications: closed and open systems. The inventory process referred to here relates only to closed system PCBs. Different investigation methods are followed with open applications involving environmental releases and these do not apply to closed applications. These investigations apply to such phenomena as concentrations of PCBs in the ecosystem (sediments, phytoplancton, zooplancton, mammal marine animals, food chain, etc.).

The PCB inventory has two purposes:

- To list all PCB owners and the current quantities of the PCBs;
- To ensure that PCB appliances can be braced up to the time of their final destruction.

The procedures to be followed are of two kinds:

- Gathering information;
- Using information contained in a database.

It is therefore essential that all the concepts employed are clearly defined in advance:

- Definition of the owner;
- Definition of PCB wastes;
- Definition of the inventory categories;
- Definition of the statistics being gathered.

In addition, the available information sources and the investigation methods must be identified:

(a) *Information sources:*

- Electricity generating, supply and elimination companies;
- Supervisory agencies;
- Use of the database.

(b) *Investigation methods:*

- Site inspections;
- Questionnaires.

The last stage of the inventory is the processing of the results, with a view to setting in place:

- Appropriate regulations;
- An elimination plan;
- Monitoring of all existing stocks until their final elimination.

2.2 – Definitions

Definition of PCBs

The Basel Convention has defined PCBs as any substance or material with a PCB concentration of above 50 ppm. Unidentified appliances must be presumed to be PCB-containing pending their identification by screening or laboratory analysis. This definition is important because it includes:

- Transformers insulated with PCBs;
- Mineral oil transformers containing PCBs with a concentration of above 50 mg/kg;
- Capacitors;
- Power switches;
- Power distribution units;
- Insulators in very high voltage distribution stations;
- Used oils containing PCBs with a concentration of above 50 mg/kg;
- Magnetic circuit cleaning solvents;
- Contaminated solids such as rags, gloves, boots.

Particular attention should be given to mineral oil transformers. Pilot programmes have revealed a significant lack of information on this class of appliances and it is therefore strongly recommended that the awareness of managers is raised of the historic causes of the contamination of mineral oil-insulated transformers.

For surface contamination, such as walls contaminated in an explosion, the following should be taken into account:

- Surface contamination, if the wall is not porous;
- Internal contamination, if the wall is porous.

Sampling by the scratching method will ascertain which type of contamination is involved.

Definition of the PCB owner

The PCB owner is the individual or legal entity who holds on his property and for his own use electrical PCB-containing appliances.

Definition of the inventory categories

An inventory card can be prepared on the basis of one or several model cards and adapted to the specific conditions of each country. An example of an inventory card is given in annex I.

The “PCB inventory and management ” tool, developed by the Secretariat of the Basel Convention to assist decision-makers, suggests that the information required should be arranged under four headings: “Identification”, “Technical specifications”, “Safety”, “Analysis”, and “Elimination”. Details of these categories are provided in annex II.

The information gathered is designed to meet the needs of the inventory itself and also to be fed into a database for a programme for the management of operational PCB sources (transformers, capacitors, drums of liquids and drums of solids) until their final destruction. Ultimately, the inventory questionnaire is based on the following two principles:

- Principle of the mandatory declaration of ownership of PCBs;
- Principle of traceability until final elimination.

Under this framework, the PCB owner becomes a waste generator. Given this production of waste, he is responsible until the equipment and its contents are destroyed.

Other definitions and key terms – definition of a non-inflammable dielectric

The properties of a liquid dielectric may be measured by a number of criteria:

- Time necessary for deactivation;
- Flash point;
- Fire point;
- Energy released;
- Oxygen index;
- Opacity, toxicity and corrosiveness of the smoke released, etc.

The two most interesting, however are the open flask fire point index and the oxygen index.

- The fire point, or the temperature to which the substance must be heated, in an open container, for a small flame to ignite and to continue to burn spontaneously, gives an indication of the risk of accidental fire. PCBs do not have a fire point measurable below boiling, and this precisely is the current definition of a non-inflammable dielectric;

- The oxygen index, or the necessary initial oxygen content, in a mixture of nitrogen and oxygen, to sustain the combustion of a previously ignited liquid dielectric, gives an indication of the likelihood of self-extinguishment in the case of an outside fire. PCBs have a very high oxygen index, which means a high capacity to self-extinguish does not exist.

Definition of the statistics gathered:

These have several purposes:

- To identify the installations at risk in terms of precise criteria;

- To define a PCB elimination plan in accordance with several criteria, such as dilapidation, priority sites, PCB concentrations, geographical distribution, etc.

The primary purpose of these statistics is to assist in the preparation of a national elimination plan. The statistics to be gathered are the following:

	PCB transformers	Mineral oil transformers > 50 ppm	Mineral oil transformers < 50 ppm	PCB capacitors	PCB-containing drums
Quantities in operation					
Quantities on standby					
Obsolete quantities awaiting destruction					
Population curve					
Quantities by type of industry					
Total quantity of liquid					
Total quantity of Solids					
Elimination plan					
Storage capacity required					
Liquid destruction capacity					
Solids destruction capacity					

2.3 – Information sources

These can be provided by the public and the private sector:

- Public sector: The classified installations inspectorate, or equivalent service, may have lists of the sites of PCB transformer owners, in view of the possible dangers of their ownership.

- Private sector:

    - First and foremost, the electricity generating and supply companies, which have client files. These files do not specify whether or not the clients run PCB transformers, but they do contain the addresses of the owners and the date of the installations. The deadline of 1985 could be maintained, even though it post-dates the prohibition;
    - Second, the supervisory agencies, which make regular audits of the installations and which are obliged to inform the installation owners if PCBs are manifest;
    - Repair companies also have useful information.

2.4 – Investigation methods

The conduct of site visits is essential for the gathering of observations. One hitch to be avoided is making the inspection visit part of some compulsory regulations, which will often cause the visit to be refused. The owner must be left an entirely free hand to volunteer his services, while impressing on him the importance of his participation in the compilation of a national inventory of PCB stocks. A letter must be sent to the owner in advance of any visit, notifying him of its date.

Communication with those in charge of installations

- Contact the installation managers before preparing the inventory;
- Explain the purpose of the exercise;
- Plan the inventory visits;
- If possible, obtain plans of the installations, and the situation of the equipment;
- Obtain the safety plans;
- If possible, draw up a visit report after the inspection, noting any retrofitting measures that have been carried out.

Equipment required for the inventory exercise

- Overalls;
- Shoes;
- Plastic gloves;
- Safety goggles;
- Lamp;
- Gas mask;
- Notebook, pens;
- Camera;
- Sampling flasks.

Safety considerations

- Organize a safety briefing;
- If one has not been suggested, request it;
- Obtain a copy of the safety plan, if one exists;
- If there is safety equipment, make sure that you know how to use it;
- Make sure that there is someone who can guide you across the factory;
- Be guided by this person
- Follow their instructions.

Equipment inspection

- Do not touch the equipment;
- Information on the stocktaking can be found on the identification plates visible at a distance;
- If sampling of the dielectric liquid has to be carried out, have it done by the installation's technician. In no event should one try to do the sampling oneself, particularly when the equipment is in use.

2.5 – PCB sampling and screening methods

- If the transformer has already been identified as a PCB transformer, no sampling is necessary[2];
- If the transformer's dielectric has not been identified, a sample must be taken. Any unidentified transformer will be presumed to be a PCB transformer;
- The first test to be conducted is the *density* test:

[2] This recommendation forms part of preparation of an inventory to determine the total stock of PCB-containing equipment, regardless of its concentration.

- Take a 10 ml beaker;
- Pour a little water in the beaker;
- Pour a little of the dielectric into the beaker;

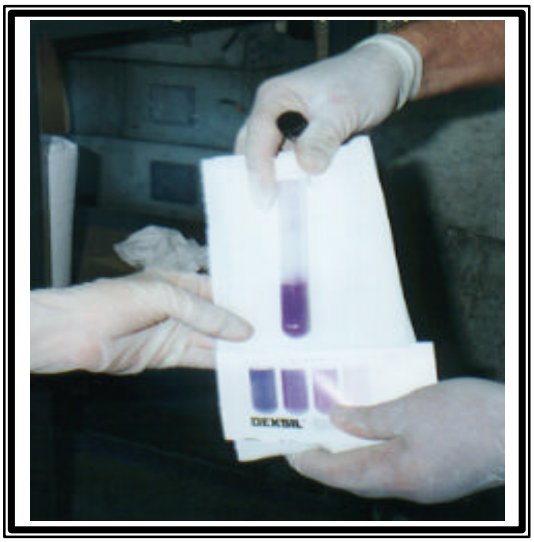
If the “oil” phase precipitates to the bottom of the beaker, its density is greater than 1. This means that it most certainly contains more than 50 ppm of PCB and there is no need to continue the tests.

If the “oil” phase remains above the water, this means that it is mineral oil, as its density is below 1, but further tests should be conducted to ascertain whether the oil has been contaminated with PCBs (phase 4).

PCB level detection test

- If the test is affirmative, this means that the PCB level is above 50 ppm. But this test is not in itself sufficient to determine the contamination level. Move on to phase 5.

- If the test is negative, the transformer may be classified as below 50 ppm, and therefore “non-PCB”.



Example of negative test: Dark colour

Example of affirmative test: Light colour

Detection of PCBs with a special chlorine electrode

This method is more accurate than that described above. It can be used when there is a large quantity of PCB to be screened in a short period of time.

The advantages of this apparatus are that its analytical capability is much higher than that of gas chromatography (CPG) and it is much cheaper: about $10 per screening as against $35 with CPG.

SAMPLE PREPARATION

ELECTRODE ANALYSIS

To determine the contamination level a PCB analysis must be conducted by gas chromatography. Gas chromatography analyses can only be carried out in laboratories duly accredited by the competent authorities, in which both the human resources (laboratory technicians) and material resources (laboratory equipment) have been officially approved. When screening oils for PCBs, the preparation of samples and the analysis itself must be carried out according to a specific procedure. These analysis procedures (European Community, French

Standards Association (AFNOR) and ISO standards) must be followed if reliable results are to be obtained. Control tests have been made on similar mineral oil samples contaminated by PCBs in several laboratories already set up to work with gas chromatography and mass spectrometry. The results of these varied between 1 and 10. There is clearly a great need for a tailor-made validation system for the screening of mineral oils for PCBs.

2.6 – Technical report

This is compiled directly from the data and can be undertaken after a visit to the firm in question. The technical recommendations given below apply to retrofitting measures for equipment to ensure the sound environmental management of PCBs.

	TECHNICAL RECOMMENDATIONS FOR RETROFITTING	**(examples)**	
24	Drums must be stored under safe conditions, with no inflammable liquid in the vicinity, and must be labelled PCBs;		
28	PCB transformers must be declared to the competent authorities;		
29	Possession of PCB transformers must be declared to the competent authorities;		
31	If the transformer has been retrofilled, the oil from the transformer must be analysed to determine its PCB content;		
33	If the dielectric has not been identified it must be analysed;		
39	The transformer must be stored under safe conditions;		
40	The transformer must be stored under safe conditions;		
41	A PCB label must be visible on the transformer;		
42	If not, a PCB label must be attached to the wall of the workshop where the transformer is located;		
43	A PCB label must be placed outside the premises;		
44	A PCB alarm must be in operation on the appliance as well as inside and outside the workshop;		
46	The volume of the catch basin must be greater than the quantity of PCB contained in the transformer (PCB density: 1.5 - vol = wt/density);		
47	A catch basin must be installed below the transformer;		
50	The period of time between inspections should be reduced for safety reasons;		
51	Inspections should be carried out in accordance with the age of the transformer;		
53	The level should be checked during each inspection;		
55	The insulation should be checked during each inspection;		
57	Regular analysis is recommended to ascertain the dielectric properties of the fluid;		
59	This safety device is strongly recommended for PCB transformers;		
62	This safety device is strongly recommended for PCB transformers;		
65	If the PCB concentration is greater than 50 ppm, the transformer must be declared to the competent authorities as a PCB transformer;		
66	The dielectric must be sampled to ascertain its PCB content;		
68	Test recommended to ascertain the dielectric properties of the fluid;		
70	Test recommended to ascertain the dielectric properties of the fluid;		
71	Either the PCB transformer is replaced by a mineral oil transformer or a fire-wall must be erected between the two appliances;		
73	Connections to the air conditioning system must be sealed;		
76	Ventilation of the workshop must be sufficient to cope with the release of toxic gas should the need arise;		
78	It is recommended that access be restricted to authorized personnel;		
79	Repair work to the transformer is necessary;		
81	Contaminated material must be removed and a decontamination inspection carried out and a report submitted to the competent authorities;		

84	If the PCB level is greater than 50 ppm, a gas chromatography analysis must be carried out;	
85	A PCB check must be made and the result transmitted to the competent authorities.	

2.7 – Risk diagnosis

A risk diagnosis is drawn up for each of the sources listed. This is compiled from information contained in the database. The competent authority can decide on specific measures according to the combined criteria of safety and maintenance. The criteria used in the framework for the preparation of risk diagnosis may be weighed.

	RISK DIAGNOSIS - LIST OF CRITERIA (example)	
33	If the dielectric has not been identified, it must be analysed;	
41	A PCB label must be visible on the transformer;	
42	A PCB label must be attached to the wall of the workshop where the transformer is located;	
44	PCB markings must be clearly visible on the appliance as well as inside and outside the workshop;	
46	The volume of the catch basin must be greater than the quantity of PCB contained in the transformer (PCB density: 1.5 - vol = wt/density);	
47	A catch basin must be installed below the transformer;	
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71	Either the PCB transformer is replaced by a mineral oil transformer or a fire-wall must be erected between the two appliances;	
73	Connections to the air conditioning system must be sealed;	
76	Ventilation of the workshop must be sufficient to cope with the release of toxic gas should the need arise;	
78	It is recommended that access be restricted to authorized personnel;	
79	Repair work to the transformer is necessary;	
81	Contaminated material must be removed and a decontamination inspection carried out and a report submitted to the competent authorities.	
	A transformer more than 35 years old must be replaced	
	TOTAL weigh	

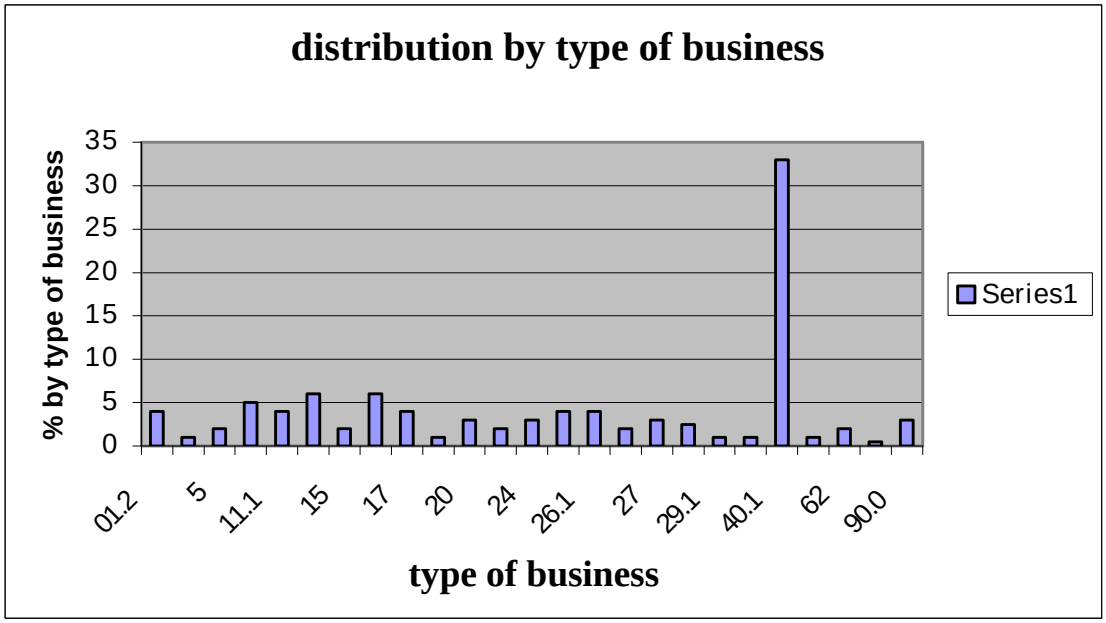
3 – Use of statistical data

The inventory data will be set out and processed to provide quantified information on the main trends observable from national surveys. Statistics can thus be worked out for the following issues:

- Distribution by type of business;
- Distribution of PCBs by age;
- Numbers of PCBs to be dealt with per year/other period of time;
- Distribution by capacity level;
- Distribution by concentration level.

This information will help in the realization of the two principal objectives of the report, which are the preparation of a regulatory framework and the formulation of a national management plan.

3.1 – PCB distribution by type of business

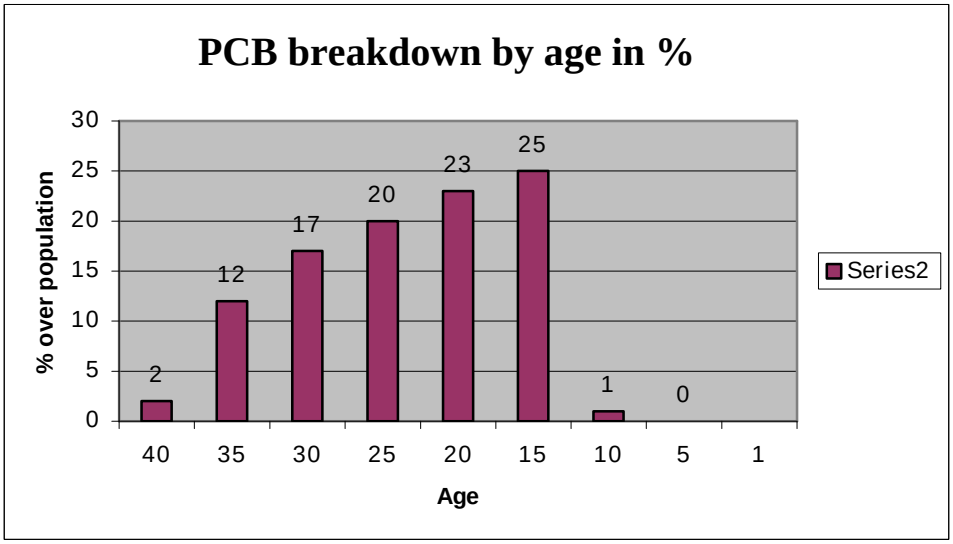


This data is interesting in that they can be used in preparing an overall diagnosis to guide decisions relating, where applicable, to preventative measures to be taken in certain sectors of activity where PCBs present specific risks, as for example public places:

- Schools;
- Restaurants;
- Hospital environment;
- Administrative offices;
- Others.

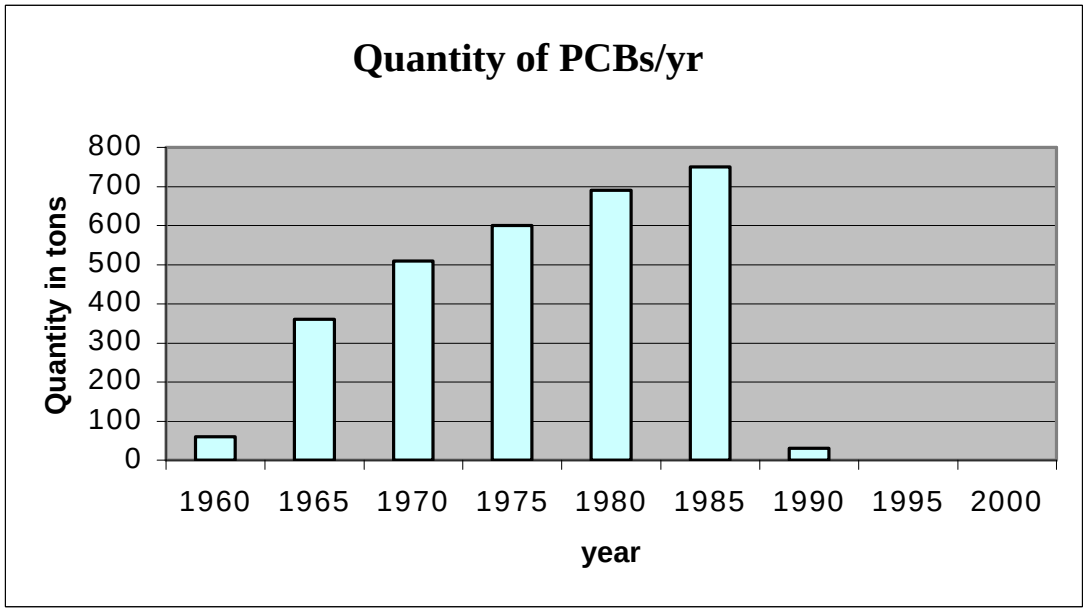
3.2 – PCB distribution by age

This classification is useful in the drawing up of a population graph showing the number of appliances which have reached scrapping age at any given period of time.



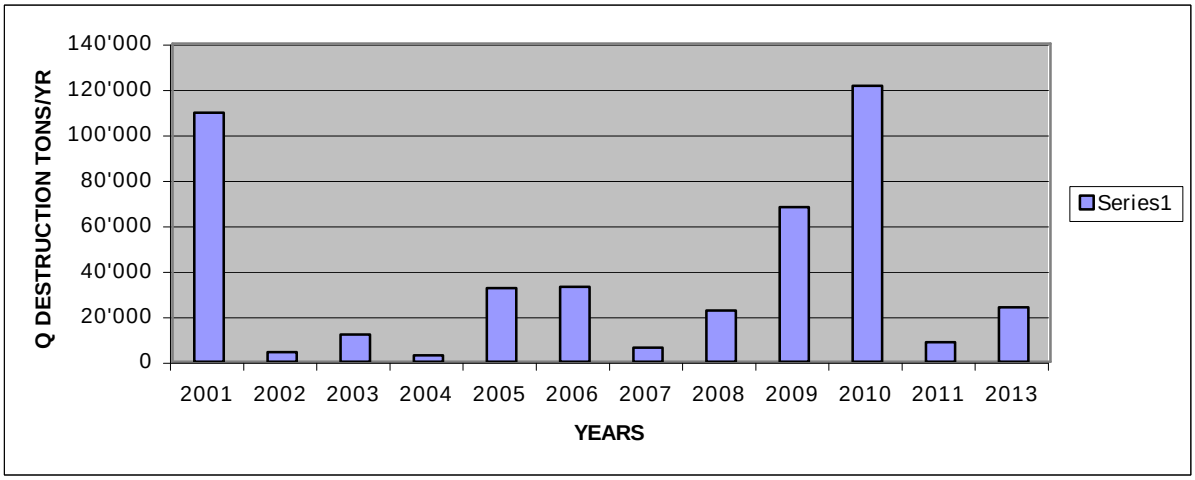
The peak of the graph corresponds to transformers installed in 1985, the year when PCBs were made the subject of control in industrialized countries.

The same data expressed in tons:

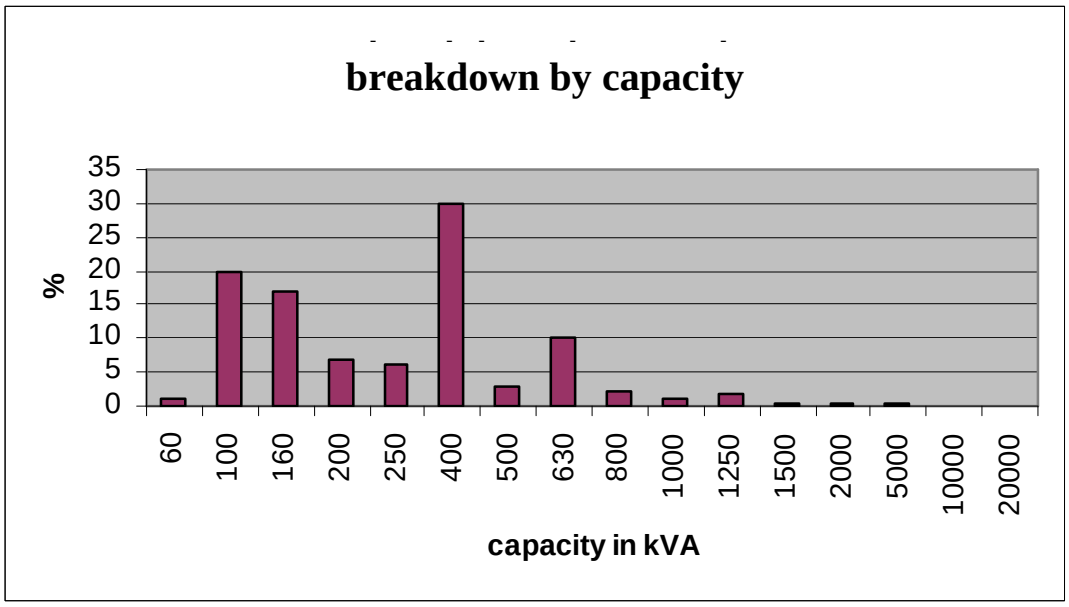


3.3 – PCB phase-out plan

Using the quantity of existing supplies and the date at which the appliances are to be scrapped, a destruction graph for the period in question can be worked out as things stand, the destruction period will last until 2013.



3.4 – Distribution of PCBs by capacity



Using data from the laboratory analysis of PCBs and contaminated oils, a more focused study will establish the distribution of known PCBs by concentration levels. This information will be particularly useful in deciding priorities and identifying the most suitable technologies in accordance with known quantities and concentrations at the national level. The implementation of concentration measures for the stock as a whole will, however, be an expensive exercise.

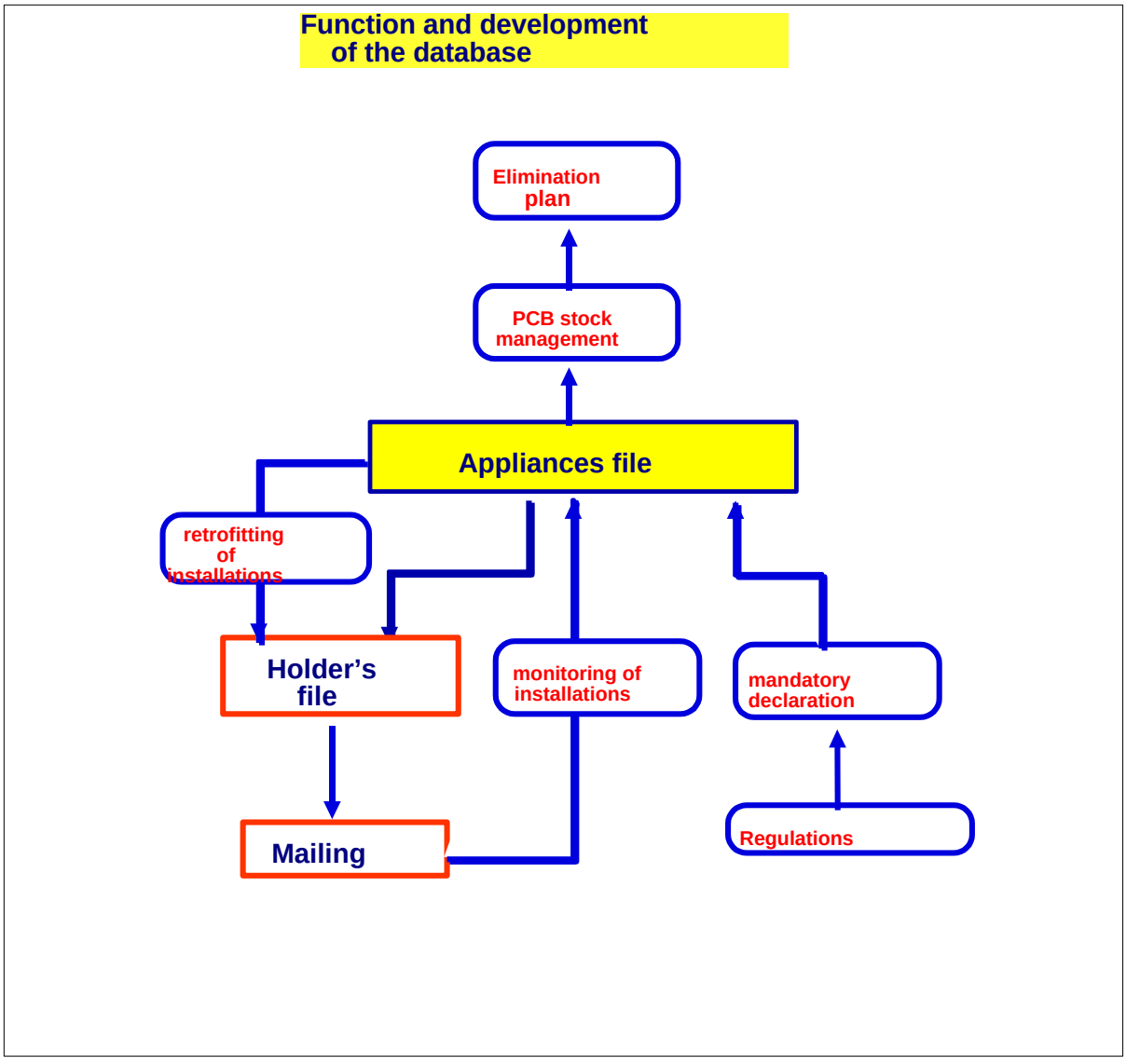
3.5 – Creation and maintenance of a data base

The database is designed to be brought up to date using information which the owners are required by law to provide, including:

- Identification of appliances and the obligation to declare possession of PCBs;
- Declaration of transformers to be scrapped, and the mandatory presentation of certificates of destruction.

The diagram given below illustrates the tasks performed by the database in assisting the accredited organizations to manage the national stock of PCB-containing equipment, by ensuring follow-up throughout their service life[3]. It is therefore possible:

- To coordinate the preparation of a national inventory of PCBs;
- To ensure the personalized follow-up of appliances and batches of PCBs (and listed establishments), to send leaflets to the owners concerning the retrofitting of their listed installations, and to update them on information about these installations;
- To ensure the follow-up of PCBs at all stages, from the point when they are put to use, to their storage and final elimination;
- To compile a body of local or national statistics on PCBs;
- To provide useful information for the preparation of a national PCB management plan.



[3] A basis of this kind has been prepared by the Basel Convention Secretariat and is at the disposal of all Convention parties.

4 – Preparation of a national PCB management plan: Preliminary elements

4.1 – National strategy

The data gathered in the inventory will help in the elaboration of a national plan for the environmentally sound management of PCBs. This plan will define government policy on the issue and will deal with the following aspects:

- Implementation or maintenance of the national inventory;
- Conditions for labelling and analysing PCBs and PCB-containing equipment, and general technical prevention measures;
- Technical plan for the management of PCBs and PCB-containing equipment (storage, transport, final elimination etc.);
- Parties involved;
- Financial plan[4].

4.1.1 – Basic objectives

A national PCB management strategy will pursue the following basic objectives:

PCB phase-out
Eliminate all measurable discharges of PCBs into the environment, starting with enclosed areas, and work steadily towards the suppression of all PCB use likely to cause a discharge that might be impossible to contain. A PCB phase-out strategy must take into account risks to human health and the environment, as well as economic and technical factors.

Environmentally sound management of PCBs throughout their life-cycle
This covers the use, storage, and domestic and transboundary movement, as well as the treatment and elimination of PCBs. It also includes preventative aspects at all stages of the life-cycle, as well as the maintenance and retrofitting of PCB-containing equipment. The notion of environmentally sound management of PCBs, as developed in the Basel Convention, will be applied in its totality[5].

Integration of PCB management into the national environmental management programme
Decisions on PCB management will be taken in accordance with the overall objectives of environmental management at the national level, in particular the management of chemicals and hazardous wastes, as well as within the framework of the relevant environmental conventions (the Basel, Rotterdam and Stockholm conventions). PCB management objectives must not ignore the industrial context of environmental management and should aim to reinforce environmental management policies at the level of individual owners or companies.

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[4] The finer details of the preparation of the financial plan will not be dealt with in this chapter (see chapter 8 entitled “Financial tools for the management and destruction of PCBs”).

[5] See the Basel Convention technical guidelines on wastes comprising or containing PCBs, PBBs, PCTs (first version 1992, Draft new version, 2002).

4.1.2 – Guiding principles for a national strategy

There are important principles guiding not only the implementation of a national management plan for PCBs but also its preparation. These principles apply to all the issues arising from PCB management.

Principle of life-cycle management
The environmentally sound management of hazardous wastes, as defined by the Basel Convention, is not confined to the environmentally sound management of the processing and elimination of such wastes. The national plan must apply to the total life-cycle of PCBs: in other words, it must ensure that they are only used in optimal conditions and that such use is phased out in a gradual and appropriate manner and it must also deal with the transport, storage and processing or elimination of PCB-containing wastes. This principle will be applied in accordance with the directives laid down by the Basel Convention together with additional considerations drawn from such international environmental agreements as the Stockholm Convention and the Rotterdam Convention.

Principle of safety and prevention
One of the essential prerequisites for sound PCB management is the prevention of pollution caused by the release of PCBs into the environment. Pollution prevention involves the application of procedures, methods, materials and products at every stage of the PCB life-cycle, as a way of avoiding completely or reducing to an absolute minimum the production of pollutants and wastes, as well as reducing the general risks posed to human health and the environment. Since their manufacture was banned the total mass of PCBs has not increased. To ensure that this given mass is further diminished and to protect the environment and human health it is important to create conditions for the environmentally sound management of existing PCBs to avoid any risk of inadvertent or careless release of PCBs.

The national plan will apply the safety principle, as strictly as is necessary, according to available resources and the national capacity for implementation. Too strict an application of the safety principle could contribute to the failure of the national plan.

An environmentally sound plan for the management of PCBs does not have to centre on their destruction. The presence of PCBs in electrical installations is actually a safety factor from the technical viewpoint. The exceptional dielectrical qualities of this fluid, particularly its thermal and chemical stability, have helped provide ways of dealing with inflammable fluids. Consequently, a gradual phase-out of PCBs is proposed, backed up by administrative and technical monitoring of PCB-containing equipment, to be carried out by duly authorized bodies.

The management plan must take account of the need for storage of scrapped appliances that are awaiting elimination. Such systems as the recycling of ferrous and non-ferrous metals and the collecting of used oil have traditionally been key links in the re-processing chain of these products without, however, any consideration being given to the environmental repercussions of their PCBs. The “market value” of these products is another contributory factor in the release of PCBs into the environment. A case in point is the production of copper through the open-air burning, fuelled by used tyres, of magnetic circuits from transformers. Up to 20% of a transformer can consist of copper, worth $1,000 per ton.

Potential problems are posed by the recycling of PCB liquids, for example, for use as a fuel substitute. This would mean mixing PCBs with motor oil. The level of dilution in such cases

could mean that concentrations were kept below 50 ppm, but the PCB mass would remain the same and combustion would bring about the production of dioxins (PCDD) and furans (PCDF).
The management plan should also prioritize pollution risks. Several countries have included priority criteria in their regulations applicable to the elimination of transformers that are more than 35 years old and need replacing immediately. Another risk factor concerns the location of the transformer. There are certain public locations where measures should be taken to remove transformers. Locations where elimination is of a high priority include:

- Hospitals and clinics;
- Medical centres;
- Commercial centres;
- Schools and universities;
- Agro-food industries and manufacturers of food products;
- Water and sanitation services;
- Government offices;
- Buildings frequented by the public.

Regulatory policy
The plan must be underpinned by the regulatory framework of national and international obligations. For the most part, implementation of the plan will be driven by international agreements and obligations[6]. PCB management, for example, including the monitoring of any possible transboundary movements, must be carried out in accordance with recognized international norms and obligations, especially the control systems set up by the Basel Convention.

The possession and use of PCB transformers and capacitors at the national level must be subject to regulations that will control their impact on the environment. These regulations shall stipulate:

- The obligation to declare possession to the relevant authorities;
- The obligation to ensure their elimination in authorized facilities;
- The obligation to declare any accidents;
- The retrofitting of existing installations;
- The security of existing installations;
- Giving priority to installations at risk;
- Emergency plans;
- Other measures.

Certain countries feel that a system of regulations is the best long-term guarantee of the gradual phasing out of PCBs. It gives a shared sense of responsibility to everyone involved as well as defining their individual areas of responsibility. It also ultimately allows for recourse to measures. Regulations, however, can only be effective to the extent that the parties involved have the capacity to implement them. In some cases they can even produce negative results as when, for example, they bring a given problem to the awareness of the owners without offering any real solutions.

[6] In this context, see, in annex XI below, the articles and annexes of the Stockholm Convention which are relevant to PCB management.

Some operations involving stocktaking and the final elimination of limited quantities of PCBs have been very successfully carried out entirely without recourse to any regulatory framework. These operations have been successful because they have comprised projects focused on specific objectives and totally funded by external sources. This kind of operation, however, is limited in terms of its timespan and scope.

Principle of the development and transfer of technology
The national management plan makes prevision for the development of a technical PCB management plan covering the decontamination of equipment and the destruction of PCBs. While taking into account various technical, economic, social and cultural factors, the aim is to strengthen the national capacity of each individual country to process its own PCB wastes.

This raises the question of which technologies to choose for the treatment and elimination of PCBs. To this end, individual countries can develop a national mechanism for identifying and choosing suitable procedures, techniques and technologies for PCB management. These countries can also use the tools placed at their disposal by the Basel and Stockholm conventions which are relevant to the final elimination of PCB wastes.

In this context, once the technical options have been chosen, national needs (or, possibly, regional needs, such as the principle of regional integration set out below) must be satisfied in the following areas:

- Treatment capacity;
- Treatment costs;
- Environmental impact.

Treatment capacity must be commensurate with the amount of PCBs to be destroyed within a given period, bearing in mind that while the capacity is technically linear the needs are not, as can be seen in the population graphs for transformers in current use. One could reasonably expect that these installations will keep on functioning for more than ten years since the most recent PCB-containing transformers will become obsolete around 2015-2020.

To enable potential installations to operate to full capacity and to compensate for the variation in destruction capacity needs, a possible solution could be the erection of temporary storage facilities. A design for a temporary storage module is proposed in chapter VI.

With regard to the decontamination of solid sections of the transformer, one possible solution would be the setting up of decontamination workshops by developing suitable technological partnerships. Ultimately these mobile PCB-destruction plants, together with other technology already available on the market or still at various stages of development and implementation, could all be considered in the overall evaluation of national (and regional) technical plans.

Principle of regional integration
Additional principles flowing from the Basel Convention will be applied in a combined and balanced way, given the significant degree to which they are all mutually interdependent[7].

[7] For this subject see the publication "Guidance in developing national and/or regional strategies for the Environmentally Sound Management of Hazardous Wastes", Basel Convention Highlights No. 96/001, Geneva, November 1997.

The first of these is the “proximity principle”, according to which the elimination of hazardous wastes must be carried out at a location as close as possible to the production site of the said wastes, even though it may be more economical and environmentally friendly to treat certain wastes in specialized centres situated some distance from the waste production site.

Another is the “self-sufficiency principle”, according to which each country has to ensure that the elimination of wastes produced on its territory must be carried out using environmentally sound management methods, again while conceding that it may be more economical and environmentally friendly to treat certain wastes abroad. This principle should be applied with due regard for the principle of the development and transfer of the technology referred to above.

The third is the “principle of least transboundary movement”, according to which the transboundary movement of hazardous wastes is kept to a bare minimum, while the efficient and environmentally sound management of these wastes is still ensured.

In applying these principles to PCB management it must be recognized that the current infrastructure of PCB management in developing countries has some bearing on decision-making. With few exceptions, these countries do not possess the necessary infrastructure either for the treatment of contaminated equipment or for the destruction of PCBs. In any event, PCB stocks in most of the countries concerned are relatively small, and below the critical volume that would justify the creation of national infrastructures for treatment and elimination. In view of these considerations, the responsible national officials are encouraged to explore the different technical and technological choices, in accordance with the principles cited above, at both regional and subregional levels.

In certain circumstances the principle of regional (or subregional) integration presents certain advantages in technical, regulatory and financial terms for the group of countries involved in such integration. As for the PCB management methods in use within the regions, it should be noted that the PCB-containing wastes are limited in quantity and in lifespan. Consequently, the needs for a PCB management infrastructure must be weighed within the overall framework of hazardous waste management. There are also grounds to expect that, if those areas that lack the necessary technology delay the implementation of PCB-containing waste management until they obtain that technology, the consequent risks to health and the environment could be perpetuated.

4.2 – Guiding principles for a national PCB management plan

Below we list the guiding principles referred to above as applied to the development of a national PCB management plan:

- Stocktaking:
  - Compulsory declaration of possession of PCBs;
  - Ensuring that PCBs and equipment can be tracked until the point of treatment and final elimination;
- Maintenance of equipment:
  - Monitoring of PCB-containing equipment until the end of its natural life;
  - Retrofitting of existing installations;
  - Temporary safe storage of equipment awaiting adequate a satisfactory technical means of decontamination or final elimination;

- Technical aspects:

  - Exploring domestic solutions for the decontamination of PCB-containing equipment;

- Financial aspects:

  - Implementation of the polluter pays principle and the shared responsibility principle;
  - Giving priority to high-risk installations.

4.3 Regulatory framework for the national PCB management plan

An initial and vital step in the national strategy will be the preparation and implementation of national regulations covering the whole body of issues referred to previously – namely, the management of PCB-containing equipment in use up to final elimination on the basis of the life-cycle principle.

For the purposes of designing and implementing such regulations, a working group must be set up to ensure that the regulation modalities take due account of the various technical and financial constraints affecting those involved, particularly in the public and the private sector. Draft regulations are proposed in chapter VII of the present manual. These regulations will cover all the environmental aspects related to the possession and use of PCBs:

- Area of application;
- Definitions;
- Inventories;
- Maintenance of PCB-containing equipment and accident prevention;
- Prevention;
- Final elimination of PCBs and decontamination of scrapped appliances;
- Emergency plan in case of accidents;
- Norms and standards of management, analysis and treatment;
- Monitoring and decontamination of sites.

The following section briefly describes the different regulatory phases of a national PCB management plan and suggests scenarios for a regulatory approach.

4.3.1 – Declaration procedure

The owners of any appliance with a volume of PCBs in excess of 5 dm^3 are required to declare their possession of it to the competent authorities of the administrative region in which the appliance is located within X months of the publication of the decree. With electrical capacitors the threshold of 5 dm^3 is relative to the aggregate PCB volume of an entire plant. The declaration must contain the following information[8]:

- Owner's name and address;
- Location and description of appliance;
- Amount of PCBs contained in the appliance;

[8] See the PCB declaration form in annex I.

- Date and type of treatment or substitution carried out or planned;
- Date of declaration.

4.3.2 – Preparation of the national inventory

The competent regional authority, working on the basis of the declarations referred to in article 1 above, shall draw up, within X months of the publication of the decree, local inventories of scrapped appliances to be forwarded to the competent national authorities with a view to the establishment of a national inventory of stocks.

This national inventory will be kept up-to-date by the competent national authority so as to ensure that the whole body of PCB-containing appliances can undergo regular follow-up inspections in accordance with the plan set out in section 4.3.8.[9]

4.3.3 – Labelling of appliances

Appliances itemized in the course of the inventory exercise referred to in section 4.3.2 above must be labelled by their owner. A similar label should be attached to the doors of the site where the appliance is kept (see details in annex III).

4.3.4 – Dispensation arrangements for mineral oil transformers

Dispensation from the provisions of sections 4.3.1 and 4.3.3 can be made in the cases of appliances containing a liquid volume of between 500 ppm and 50 ppm of the substances referred to in section 4.3.1. These appliances will be labelled "PCB contamination less than 500 ppm". Specific provisions must be made for the presence of PCB-containing appliances within a range of mineral oil appliances as this situation presents increased risk.

4.3.5 – Drawing up the technical plan

On the basis of the national inventory exercise referred to in section 4.3 above, the ministry in charge of PCB management (e.g. the focal point of the Basel Convention) must draw up a draft technical plan for the decontamination and elimination of listed appliances within a designated period of X months from the publication of the decree.

This draft plan provides a timetable for the elimination of PCBs and the elimination or decontamination of listed PCB-containing appliances, which would guarantee elimination or decontamination by a designated date (before 2005 at the latest), with the exception of transformers that have a liquid content of between 500 ppm and 50 ppm of the substances in question, which are to be eliminated at the end of their working life. It also makes provision for ways of keeping to the timetable. Furthermore, it lists the methods for collecting and eliminating other, non-listed PCB-containing appliances reaching the end of their working lives, including household appliances.

Possible technical solutions (procedures and technologies) to the problem of waste management should be systematically and comprehensively explored, taking into account economic, social and environmental criteria (prevention of toxic emissions, controlled management of discharges, etc.). In this context, the technical directives developed under the various international bodies (e.g., Basel and Stockholm conventions) can provide methodological tools that will be useful in selecting procedures and technologies.

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[9] See information on database management in section 3.5.

4.3.6 – Contributors to the national management plan

The relevant ministry will be helped in drawing up the draft plan referred to in section 4.3.5 above, for the purpose of analysing information concerning its implementation and final review by a commission comprising:

(a) Officials nominated by the ministers responsible for the environment, industry, home affairs, defence, transport, health, trade and handicrafts;
(b) Local community representatives (towns and regions);
(c) Representative of the national environmental agency;
(d) Representative of the national agency for food safety;
(e) Representatives of companies working towards the exploitation and elimination of PCB-containing appliances;
(f) Representatives of approved environmental protection organizations.

The relevant ministry will decide on the composition of the commission, nominate its members, define their role and designate its secretariat.

4.3.7 – Publication of the national management plan

The draft plan will be available for consultation by the public, both in local government offices and in the Ministry of the Environment for a designated period of X months; a public announcement of the opening date of this consultation period must be published at least 15 days in advance in two national newspapers.

4.3.8 – Ratification of the management plan

The draft plan will be submitted to those in charge of classified installations for their information. It will be approved by order of the Minister of the Environment after consultation with the other ministers concerned. The plan can be consulted in the Ministry of the Environment and in local government offices.

5 – General on-site technical safety measures

General on-site technical safety measures should be issued in the form of directives which will help promote the enforcement of the regulations within the area in question. The following elements of such directives are provided for information only.

5.1 – General technical safety measures

Because of the noxious properties of PCBs and their ability to bio-accumulate, strict safety and protection measures must be applied during the storage, handling and use of these products. It is therefore necessary:

- To warn staff of the risks posed by these products, the necessary precautions to adopt, and the measures to take in the event of accidents;
- To prohibit, because of the risks of decomposition and subsequent release of toxic substances, the use of any flame-producing appliance in the presence of PCBs, or any appliances which raise the temperature of a metallic surface to high levels (this means the banning of any welding operations and the oxy-acetylene cutting of PCB-containing transformers);
- To avoid as far as possible the release of vapours in workshops where PCB-containing appliances are repaired, ensure good ventilation in work stations, regularly test the air at the level where it is inhaled by staff;
- Store products and wastes in sealed and labelled metal containers which must be kept in adequately ventilated premises;
- Avoid any contact of the products with the skin or the eye area. For this purpose staff must be provided with suitable protective gear:

    - Gloves (e.g., made of fluorine elastomer);
    - Wraparound goggles;
    - Overshoes.

  See annex VII for first aid instructions to be followed in case of accidents.

5.2 – Preventative measures to be taken against the risk of cold pollution

First of all, regular checks should be made of the *watertightness of the appliances*, but in all cases a watertight mechanism should also be available for the *containment of spills*:

- Existing installations: The existing retention system can be maintained if it is watertight and if there is no danger of overflow seeping into the natural environment or the public sanitation network;
- New installations: The mechanism must have a minimum capacity at least equal to the highest of the following values:

    - 100% of the capacity of the largest container;
    - 50% of the total volume stored (thus, a workshop in which there is a transformer containing 400 litres of pyralene and two other transformers containing 300 litres each must have a minimum retention capacity of 500 litres);

- The requirement to have a watertight retention mechanism does not apply to capacitors permeated with PCBs in the form of gel, as this is not likely to escape if the outer casing were to break;

    - Workshops for repair work, recovery, decontamination and stripping down:
    - Same measures to be taken as described above;
    - The flooring of each set of premises must be also be made watertight and easy to decontaminate. To this end, it would be advisable to have raised thresholds and to block all openings through which pyralene might spill (e.g., cavities for the passage of cables);
    - Underfloor water drainage and all gas piping is prohibited.

5.3 – Measures to be taken in the event of "cold" accidents

- Alert the relevant authorities (e.g., the classified installations inspectorate) in the event of any spreading of PCBs and risk of contamination to the environment;
- Alert the duty doctor and make sure the staff are equipped with PCB-protective outfits: wrap-around goggles, gloves and overshoes;
- Mark out a safety perimeter and, where necessary, ventilate the premises using all the means available;
- Limit PCB spill by sealing the breach (using pieces of rag, plastic film) and by using absorbents (such as sand, sawdust, cement);
- Clean the flooring:

    - If it is watertight:
      - Scrape thoroughly and use steam to soften the PCBs;
      - Under no circumstances must a flame without protection be used. Chlorinated solvent should not be used, using only mild Teepol-based detergents – such as dishwashing liquid;
    - If it is not watertight, heavily contaminated underfloor supports must be removed: concrete, earth etc.;
    - If there is any risk of ground water contamination the appropriate measures must be taken immediately to limit, settle and ultimately eliminate the pollution.

- Place all the polluted products that have been gathered up (washing water, earth with a higher than 100 ppm pollution level, clothing etc.) in watertight containers for their subsequent destruction by incineration at an authorized site.

Note:
- Soil with a pollution level higher than 100 ppm must be treated;
- At a concentrate between 10 and 100 ppm it should be disposed of in an approved landfill or kept on site;
- At under 10 ppm it is considered non-contaminated;
- Water cannot be thrown out unless its PCB content is less than 0.5 µg/litre.

5.4 – Measures to be taken to avert "hot" accidents

To avoid the possibility of dielectrical decomposition, which can occur when toxic vapours reach 300°, the following steps must be taken:

- Ban the accumulation of all inflammable matter (paper, cardboard cartons, rags, paint, solvents) from the vicinity of the equipment or block off the equipment using two hour rated fire-walls (one-hour rated fire-doors) to protect it from the possibility of fire from the outside;
- Inform fire and emergency services of the presence of PCB-containing equipment, so that their emergency procedures can be adapted accordingly;
- Check (or have checked by an approved organization) that the PCB-containing appliances are not operating on electrical overload;
- Check that the electrical equipment has protection ensuring it switches itself off in the event of any internal malfunction and issue instructions banning the manual re-starting of the equipment before the cause of the original malfunction can be determined;
- Ensure that gas is kept properly sealed. The sites where PCBs are handled and PCB-containing appliances are kept must be partitioned off from sites where other activities are carried out. It is particularly advisable to take steps to ensure that any smoke and vapour resulting from an accident should be prevented from reaching neighbouring sites or offices (by way of technical shafts, ventilation pipes, waste disposal pipes, etc.).

5.5 – Action to be taken in the event of an accident caused by an electrical fault or a fire

- First scenario: the transformer is intact. There has only been some internal priming, and melting of the fuses:

    - Do not replace them without testing them first and do not open the transformer without taking precautions;
    - Use an oxygen mask with a gas filter as the internal pressure may have risen adding to the risk of an escape of hydrochloric gas;

- Second scenario: arcing has occurred, leading to a crack in the tank of the appliance but no decomposition in the presence of oxygen (no fire). This type of accident involves the spread of PCBs in a liquid state with hydrochloric acid vapours. It is a "cold accident" situation and the measures to be taken are those prescribed for the previous scenario;
- Third scenario: there has been re-priming of an open, run-down appliance or a fire in the plant. Both cases present a risk of PCB decomposition due to heat and the presence of oxygen and the formation not only of hydrochloric gas but even more significantly of toxic compounds, furans and dioxins. There is consequently a risk of "hot pollution". In this case, it is necessary:

    - To disconnect the unit;
    - To call the fire brigade, giving them precise details about the nature of the accident so that they will be bring the proper equipment for gaining access to the unit and fighting the fire. CO_2 and dry ice should be used rather than water, to lessen the risk of the catch basins overflowing into the natural environment;
    - To inform the relevant authorities without delay;

- To cordon off the polluted area, ensuring that access to it is strictly controlled and accessible only to persons provided with a special protective kit (waterproof overalls, goggles, mask, overshoes) and then only when absolutely necessary and for the shortest possible time;
- To confine the pollution as much as possible by sealing off all channels of communication between polluted and non-polluted areas.

The authorities may order the evacuation of the polluted area (if it is widespread) and an inspection of the contamination. This inspection is an extremely complex and delicate exercise and must be carried out under the strictest conditions. According to the results of these inspections, the classified installations inspectorate – or equivalent service – might ask the owner to take certain essential steps essential for the decontamination of the premises in question:

- Put into a container all rubble, valueless objects and contaminated clothing for their subsequent destruction by incineration at an authorized site;
- Steam-clean or solvent-wash immovable surfaces and valuable objects to eliminate any removable contamination and to reduce drastically the general contamination with a view to bringing the premises back to normal prior to their reoccupation. Even though the techniques involved are relatively simple, the decontamination of premises damaged by fire must be carried out by professionals.

5.6 – Repairs and maintenance procedures

It is possible to carry out certain standard maintenance procedures in situ, such as:

- Adjustment and standardizing of the dielectrics;
- Treatment of the dielectrics;
- Taking of samples.

For these operations to be carried out effectively the following steps are necessary:

- Give the doctor on duty a list of the personnel involved in the work;
- Provide the aforesaid personnel with compulsory PCB-protective kit; (gloves, wraparound goggles);
- Ensure that the work space is adequately ventilated;
- Avoid any release of PCBs. The work should be done on a watertight surface, with a sheet being added where necessary;
- Ensure that the maintenance materials used are adapted to and compatible with PCBs;
- Avoid all contact with naked flame and all heating of PCBs or of the appliance itself (especially where welding is involved);
- Collect all the PCB-polluted wastes produced by this work and place it in watertight metallic containers for its subsequent elimination at an authorized site.

All key operations such as decanting, rewinding of coils, changing of voltage etc., must be performed in specially equipped and duly authorized workshops.

6. Transport and storage of PCBs

Any transboundary movement of dangerous chemicals or hazardous wastes containing PCBs must respect the obligations set out in the Basel and Rotterdam conventions. Readers are encouraged to consult both conventions, and to review the legal and institutional aspects of the control of transboundary movements which apply to hazardous chemicals or hazardous wastes in general[10]. The following sections provide information of a general technical nature as well as specific technical information on the collection, transport and storage of PCBs and PCB-contaminated equipment.

6.1 – Collection and transport of dangerous materials

General obligations concerning transport operations

This covers:

- Information on the merchandise itself;
- Information about the loading of the merchandise;
- Information about the guaranteed routing of the merchandise.

Guaranteed routing

The transporters guarantee comes into force the moment he takes the merchandise on board. This has the effect of exonerating the consignor from liability for anything that might befall the merchandise between loading and delivery.

Obligation to provide information

The loader is responsible for providing the transporter with all the information needed to ensure fulfilment of the guarantee of safe delivery of the merchandise.

Obligations concerning loading, chocking and stowing

These concern the loader, not the transporter. The transporter must ensure that that these operations are carried out in accordance with the regulations governing the types of transport being used. There are five different kinds of regulation, depending on the type of transport:

- Domestic transport by land;
- International transport by land (ADR – RID);
- Sea transport (IMDG-IMO);
- Air transport;
- Rail transport.

It is therefore necessary to use the crating and packaging methods prescribed for the type of transport chosen for any transboundary movement of hazardous materials. These regulations are not specific to industrial hazardous wastes but apply to chemicals in general. In the case of wastes that contain several substances physically mixed up together, the mixture is classified according to the most hazardous of these substances. For example, a mixture of mineral oil with a PCB content above 50 ppm is classified as a PCB.

[10] Reference should be made, in particular, to the Instruction Manual - Control System for Transboundary Movements of Hazardous Wastes and other Wastes - SBC No. 98/003, March 1998.

Collection and transport of dangerous materials

1- It is crucial that the consignor of a dangerous product be aware of its chemical properties in order:

- To comply with the packaging directives;
- To provide the transporter with an exact description of the merchandise to be carried and the risks it poses.

2- The regulations vary according to the type of transport:

- The types of packaging and transport depend on the hazard class and the packing class to which the product belongs and the markings on the package:

Hazard classes

There are nine hazard classes:

1	1a: explosives
	1b: ammunition
	1c: fireworks ? flares ?
2	Compressed gases, liquefied or dissolved
3	Flammable liquids
4	4.1: Flammable solids
	4.2: Substances liable to spontaneous combustion
	4.3: Substances which, in contact with water, release flammable gases
5	5.1: Oxidizing agents
	5.2: Organic peroxides
6	6.1: Poisonous substances
	6.2: Infectious substances
7	Radioactive substances
8	Corrosive substances
9	Miscellaneous dangerous substances

Packing groups

The packaging must be appropriate to:

- The type of merchandise;
- The risks it poses;
- The methods of transport and handling involved.

It must also, in all circumstances:

- Keep the contents intact;
- Prevent contacts with contacting other merchandise.

All types of merchandise have been divided into three categories or packing groups according to the risk level, except for explosives, gases, organic peroxides and radioactive materials.

High risk	Packing group I
Medium risk	Packing group II
Low risk	Packing group III

The correct packing group for any product or object will be indicated on its card or in the general code index.

Labelling

The purpose of labelling is to identify the nature of the risks presented by the merchandise and to alert all those involved in its transporting or handling to the appropriate precautions to take. Identification and classification of the product are fundamental to all packaging, transportation and storage operations. All chemical products are itemized with a UN code and placed in one of the hazard classes and packing groups.

For example:

- Liquid waste with an NSA alcohol content (not otherwise specified) has as its UN code the number 1987, is in hazard class 3 and packing group M;
- A solvent used for drying in the electronics industry – trifluorotrichloroethane – has the UN code 1082, hazard class 2.1 and packing group M.

Equipping of road transport vehicles

This applies to:

- Electrical equipment;
- Fire extinguishers using:
    - Water;
    - Foam;
    - Halocarbons;
    - Carbon dioxide (CO_2);
    - Chemical powders;
- Miscellaneous equipment:
    - Speed restricters;
    - Hydraulic hoses;
    - Tachometers;
    - On-board accessories (battery selector switches)
    - Special protective equipment and marking materials (wrapping materials, plastic bags, plastic sheeting, absorbents, spades, masks, marking tape, empty drums – both open-top and covered, disposable overalls, special gloves and shoes for this purpose),

- Safety card clearly displayed in the cabin and warning plates outside the truck ("danger" signs and orange disks)

Special instructions:

- No transporting of inflammable products;
- The driver of the specially equipped vehicle must be made aware of the type of product being transported and the risks attached (a safety card should be included with the transport documents);
- Emergency instructions for incidents and accidents must be known so that fire, hot pollution, cold pollution, spillage and the release of PCBs into the environment can be avoided;
- Safety instructions for PCBs must be known.

Identification of drums

Drums for the transport of dangerous materials must be duly approved and identified with indelible markings to this effect marked on the outside and on the cover. These markings take the form of a code with the following elements:
Sample sign for closed drums 2001 (liquids):
Filling level: 90%

1A1	Steel drum with non-detachable top
1A2	Steel drum with detachable top
X or Y	Packing groups I, II and III
	Y for packing groups II and III
1.5	Liquid density if greater than 1.2
S	Solids or hydraulic test pressure for liquids
150	Solids: maximum gross volume
83	Year of manufacture of drum

Sample marking for liquid drum: 1A1/Y 1,4/150/94
Sample marking for solid drum: 1A2/Y 150/S/83

SPECIFIC PROVISIONS FOR PCBs

Categories of PCB-containing products

PCB wastes can be divided into several categories:

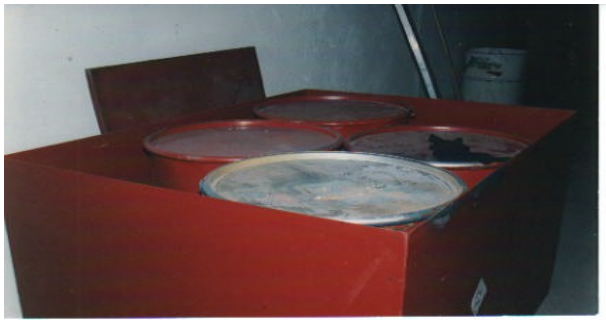
- PCB transformers that have been drained
- Liquid PCBs in drums originating from drained transformers
- Liquids polluted by PCB mineral oils, solvents, water (more than 50 ppm)
- Polluted PCB solids (more than 50 ppm)
- Capacitors

Types of packaging

Liquid PCBs:	Sealed drums with metallic and absorbent casing
Solid PCBs:	Open-top drums (solids)
Capacitors:	Watertight palleted metallic casing
Transformers:	Catch basins for drained transformers with absorbents

Taking into consideration the age and condition of the equipment to be destroyed, it is recommended that the transformers be drained before transporting. They can thus be carried emptied and drained. In any case it should be remembered that transformer tanks cannot be classified as packages approved for transport.

While UN-specification metal drums are considered approved containers for transporting these products it is still recommended that they be packed in metal bins that ensure the safety of both maintenance and transport.



For obvious safety reasons it is not a good idea to put drained transformers and PCB liquid drums into the same bins, as the drums might be damaged by the transformer shells.

Information form

UN code	2315	Chlorine content	from 42 to 60 %
IMO class:	9	Melting point	-19 °C
Packing group:	II	Evaporation temperature	325 °
Labelling:	9	Flash point	176 °
IMDG code:	9036	Density	1.5

Stowage: Category A on deck or below deck.

Movement of PCB-polluted mineral oil (> 50 ppm)

Category 3
Petroleum products not otherwise specified
IMDG code: 3375
Marine pollutants
Flash point > 61° C
Packing group III.
When there is a mixture of products the choice of transport category is based on the product with the highest risks. In this case categories 3 or 9 dominate in relation to category 9.

Transport documentation

1 - Packing certificate: The packing certificate must be drawn up by an accredited control company. This certificate must confirm that the following elements conform with the relevant transport regulations:

- Verification of the state of the containers
- Validity of the CSC data plate
- Chocking of the appliances
- Labelling
- Packing list
- Total weight of container and weight of hazardous materials

2 – Packing list: The packing list should show the number, weight and type of all appliances and packages per container, together with a summary of the weight.
3 – Declaration of dangerous merchandise (see following page)

EUROPEAN COMMUNITY (a) 10 08 2001 SY01K0098-037

TRANSFRONTIER MOVEMENT OF WASTE
Notification Form

COPY FOR:

1. Notifier/exporter (name, address) and registration N° where applicable:
☐
Contact person:

3. Notification concerning (1): **N° FI 001200**
A (i) Single movement ☐
(ii) General notification (multiple movements) ☒
B (i) Disposal (no recovery) ☒
(ii) Recovery operation ☐
C* Pre-authorized recovery facility ☐ yes ☐ no
* (Only to be completed if B (ii) applies)

2. Consignee (name, address) and registration N° where applicable:
Ekokem Oy Ab
P.O. Box 181
FIN-11101 RIIHIMAKI, FINLAND
Tel.: +358-19-71-51 Fax: +358-19-71-52-11
Contact person: Mr. Markku Aaltonen

4. Total intended number of shipments: 125
5. Total intended quantity (b): 2,500,000 kg / liters
6. First shipment not before: 31-08-01
Departure of last shipment not after: 01-09-02

7. Intended carrier(s)* (name, address) and registration N° where applicable:
THE NORTON LINE
8390 N.W. 53RD STREET, SUITE 102
MIAMI, FL. 33166
U.S.A.
Tel.: (305)599.1694 Fax: (305)418.4491
Contact person: FRED BAHR * (attach list if more than one) annex A

8. Disposal/recovery facility (name, location, address):
Same as is Indicated on box 2
Tel.: Fax:
Registration N° where applicable:
and limit of validity:
Contact person:

10. Waste generator/producer (name and address):
Several Generators, see annex B
Tel.: +528-152-21-76 Fax: +528-152-21-90
Contact person: Mr. Salomón Rojas Peña
Process and location of generation:* México
* (attach details if necessary)

9. Code N° of disposal/recovery operation (2):
and technology employed: D10
* (attach details if necessary) High Temperature Incineratio

11. Mode(s) of transport (2): R-S-R
12. Packaging type(s) (2) 1-4-5-6-8

13. Name and chemical composition of the waste: Transformers carcasses, capacitors and material contamined with Polychlorinated Biphenyls, PCB's Oil
14. Physical characteristics (2): 2,5

15. Waste identification code:
- in country of export/dispatch:
- in country of import/destination: 25208, 35128
International Waste Identification Code (IWIC): Q13//D10//S,L10//C32//H12//A170
European Waste Catalogue (EWC): 16 02 01
Other (specify):
17. Y number: Y10
18. H number (2): H12

14. OECD classification (1): amber ☐ red ☒ and number: RA010
other* ☐
* (attach details)
19. UN identification number: 2315 UN class (2): 9
and proper shipping name: Polichlorinated Biphenyls PCB's

20. Concerned countries (2), code numbers of competent authorities (where applicable), and specific points of entry and exit:

Country of export/dispatch	Transit countries			Country of import/destination
MX ALTAMIRA-VERACRUZ	US CHARLESTON GB 00 LIVERPOOL THAMESPORT	DE, 005 BREMERHAVEN	NL,001 ROTERDAM BE,004ANTWERPEN	FI001 HELSINKI

21. Customs offices of entry and/or departure (European Community):
Entry: Liverpool, Thamesport
Departure:
22. Number of annexes attached: 7

23. Notifier/exporter's declaration: I certify that the above information is complete and correct to the best of my knowledge. I also certify that legally-enforceable written contractual obligations have been entered into and that any applicable insurance or other financial guarantees are or shall be in force covering the transfrontier movement.
Name: Signature:
Date: 14-06-01

FOR USE BY COMPETENT AUTHORITIES

24. TO BE COMPLETED BY COMPETENT AUTHORITY OF COUNTRY OF IMPORT/DESTINATION
Notification received on: 21. 12. 2001
Acknowledgment sent on: 21. 12. 2001
Name of competent authority, stamp and/or signature: FINNISH ENVIRONMENT INSTITUTE

25. CONSENT * TO THE MOVEMENT PROVIDED BY COMPETENT AUTHORITY
of: (name of country) FINLAND on: 07. 01. 2002
Name of competent authority, stamp and/or signature: FINNISH ENVIRONMENT INSTITUTE
Consent valid until: 01. 09. 2002
Specific conditions (1): ☐ no ☒ yes, see block 21 annex
* (not required for countries/list systems under OECD Decision)

(1) Enter X in appropriate box(es). (2) See codes on the reverse.
(a) Forms also used by OECD.
(b) Indicate one of the two. Competent authorities are allowed to ask for the quantity in kg only.

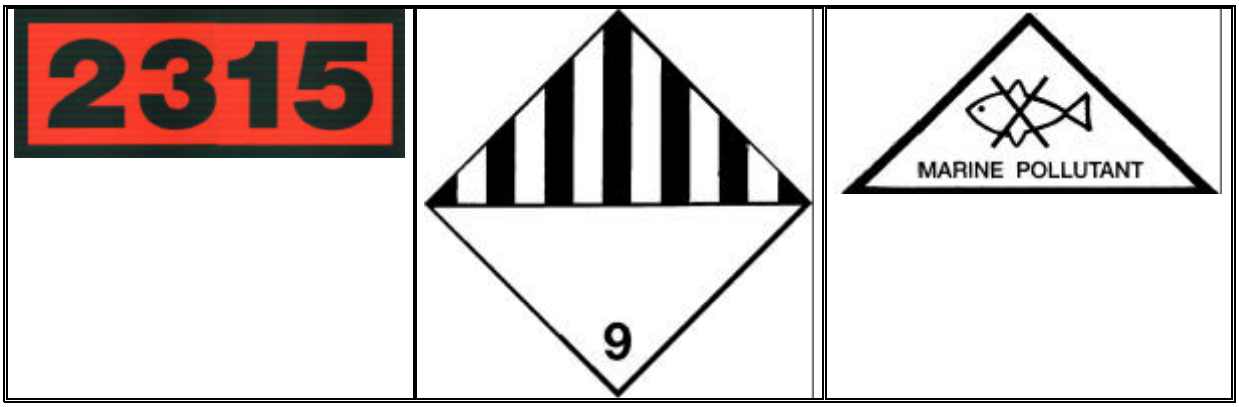
4 – Container packing diagram

This diagram shows the location of each product and how it is blocked and chocked within the container.

The appliances must be positioned in such a way as to avoid all sideways or lateral or vertical movement throughout the journey. This chocking can either be done with wooden beams or special ”airbags” approved for sea transport.	

Labelling of the container and vehicle

PCB labels (UN 2315-marine pollutant) must be attached to the four sides of the maritime containers as well as to the metal cases and the transformers inside the containers.



The containers must be padlocked and sealed. The seal number must be shown on the hazardous materials declaration.

6.2 – Temporary storage areas for PCBs

Given the history of waste production and its time-limited production, it seems more appropriate that this type of waste should have a temporary storage area specifically for PCBs. The flow of PCB wastes should however have dried up at some time in the period 2015-2020, depending on the specific country and the national regulations. Moreover, PCBs cannot be stored together with inflammable wastes which means that the creation of multi-purpose storage areas is virtually impossible.

Storage methods

First the transformers are drained into 2001-type metal drums with UN-coded seals and the drums themselves are placed in metal bins for the onward journey. This operation can be carried out on the owner’s premises to ensure transport safety as far as the storage area.

Group N°: 90 201 // UN code 2315 // IMO class: 9
Packing group: II // Labelling: 9 // IMDG code 9036

The storage area can be made up of so-called “final voyage” 40 ft containers. These cost around $2,000 per piece and have a capacity of 20 tons each.

The above photo shows a temporary storage area located in West Africa

The principle underlying temporary storage is the refusal to accept any products unless their final destination has already been determined, both contractually and administratively. “Contractually” refers to the contract of destruction drawn up between the owner and the elimination centre. “Administratively” means that an elimination procedure has been authorized for this type of waste or an export licence issued, in the event of any transboundary movement of the said wastes. Although the storage is temporary, it still has to be properly authorized.

7 – Draft regulations on polychlorinated biphenyls and polychlorinated terphenyls (PCBs and PCTs)

7.1 – Draft regulations

Draft regulations on the use and destruction of PCBs are given here by way of example. These have been based on current regulations in several developed countries and are tailored to the specific PCB-management conditions, at the various stages of the PCB life-cycle, in a "pilot" developing country. The draft is supplemented by a list of comments pertaining to each article and explaining its purpose (see section 7.2).

Proposal

MINISTRY OF THE ENVIRONMENT AND AMENITIES OF. ……[country],
MINISTRY OF INDUSTRY AND TOURISM

Decree n° of the year 2000 pertaining to polychlorinated biphenyls (PCBs) in electrical equipment and in other materials contaminated by them.

THE PRESIDENT OF THE REPUBLIC

Upon the report of the Minister of the Environment,

CONSIDERING the Constitution, particularly its article […];
CONSIDERING framework law n° […] of [date], providing the Environmental Code;
CONSIDERING decree n° […] of [date], concerning classified installations from the standpoint of protection of the environment;
CONSIDERING decree n° […] of [date], assigning the responsibilities of the Minister of the Environment;
CONSIDERING order n° […] of [date], officially listing the classified installations;
CONSIDERING the Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal;

Article 1: Definitions
For the purposes of the present directive, the following definitions apply:

(a) "**PCBs**": "Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (**PCB),** polychlorinated terphenyl **(PCT),** polychlorinated naphthalene **(PCN)** or polybrominated biphenyl (**PBB),** or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more." (Category **A 3180** of classification A of the Basel Convention)

Polychlorinated biphenyls,
Polychlorinated terphenyls,
All mixtures in which the total volume of the aforementioned substances exceeds 0.005% (50 ppm) in weight:

(b) "**PCB-containing appliances":** all appliances containing or having contained PCBs (transformers, capacitors, receptacles containing residual stocks, etc.) and which have not been decontaminated. Appliances capable of containing PCBs are considered to contain PCBs.

(c) "**used PCBs":** all PCBs considered to be wastes;

(d) **“owner”:** the person who has physical possession of or moral responsibility for PCBs, used PCBs and/or appliances containing PCBs;

(e) **“decontamination”:** the entire set of operations which enable appliances, objects, materials or liquids contaminated by PCBs to be reused, recycled or disposed of in secure facilities which can also include substitution, referring to the entire process in which PCBs are replaced by similar liquids that do not contain PCBs;

(f) **“disposal”:** This refers to the processing of PCB-containing wastes, all stages of the destruction of PCB molecules, the decontamination of PCB-containing appliances, the replacing of PCB fluid in the appliances referred to in article 4 .1, the decontamination of other PCB-containing materials and objects and the recovery of PCB fluids;.

(g) **“retrofilling”:** The replacing of PCB-containing dielectrics with non PCB-containing dielectrics..

Article 2: Implementation

The purpose of the present decree is to regulate the conditions surrounding the declaration, operation, use, handling, transport, storage and disposal of PCBs as defined in article 1 of the present decree.

Article 3: Import and transfer of PCBs

On publication of the present decree in the official newspaper of…. [country], all import, manufacture, installation, purchase, sale or transfer, whether free or against a charge, of PCBs, PCB-containing electrical equipment or materials contaminated by PCBs shall be prohibited.

The seller of a building containing a PCB appliance is subject to declaration in terms of the relevant legislation on classified installations must inform the buyer accordingly.

Any person infringing the above regulations will be subject to penalties set out in act n° […] of [date], providing the Environmental Code.

Article 4: Declaration of PCBs

PCB owners, as defined in article 1, must declare such ownership to the technical section of the Ministry of the Environment, using the form provided in annex I to the present decree.

This declaration must be made within a period of six (6) months from the publication of the present decree in the official newspaper of … [country].

All owners of appliances must inform the appropriate authorities of the quantities they contain and of any change in these quantities.

All appliances declared must be labelled. The labelling, a description of which is provided in annex III to the present decree, must clearly state the presence of PCBs and the risks that could be caused by fire. The same type of labelling should also be used on the doors of the premises where the appliance is kept.

Companies providing facilities for the storage, containment or disposal of PCBs must keep a register detailing the quantity, origin, nature and PCB content of the used PCBs delivered to them. This information is then transmitted to the appropriate authorities.

Appliances that were retrofilled before the present decree came into force must be declared as PCBs if PCB screening was not carried out on the dielectrics.

Appliances whose dielectrics have not been marked on their identification disks and which have not undergone PCB screening must be declared as PCBs.

Article 5: Retrofilling of existing installations

All equipment in current use containing PCBs as defined in article 1 of the present decree is obliged to be retrofitted according to the methods defined in annex II.

Article 6: Repairs and retrofilling

Repairs to PCB transformers in use, as defined in article 1 of the present decree, are authorized subject to the technical conditions defined in annex IV. Retrofilling of PCB transformers in use is forbidden.

Article 7: Technical inspection

The electrical equipment referred to in article 1 is subject to annual inspection performed by an authorized company and consisting of:

- Visual inspection, at minimum, of the watertightness or absence of leakage of the appliances and retention units;
- Check of the dielectric level;
- Check for the presence of inflammable liquids or solids on the same premises.

This inspection must be carried out by an authorized company and the results forwarded to the classified installations inspectorate.

The first inspection must be carried out no later than 12 months after the entry into force of the present decree.

The authorized company will use the results of the first inspection to decide on the subsequent timetable of inspections.

The technical visit reports must be forwarded to the Ministry of the Environment.

Article 8: End of working life

The PCBs referred to in article 1 of the present decree must be disposed of before 2013.

All persons owning, in any capacity whatsoever, wastes containing PCBs, must have these treated at sites authorized by the Ministry of the Environment.

PCB-containing electrical equipment currently in use can continue to function subject to retrofitting according to the conditions of use defined in annex II.

Article 9: Final disposal of PCBs and decontamination of scrapped appliances

PCB-containing materials and appliances as defined in article 1 can only be disposed of in conditions determined by order of the Ministry of the Environment.

It is forbidden to mix PCB-containing wastes with other wastes or with any other substance prior to their being handed over to the authorized company.

Diluting measures aimed at reducing PCB concentration to a pollution level lower than 50 ppm are forbidden. Material impregnated with PCBs cannot be scrapped before being decontaminated to a permanent level of less than 50 ppm of the mass of the object in question.

Dumping and straight burning are forbidden.

Any company involved in storing, containing, decontaminating and disposing of used PCBs and/or PCB-containing appliances must be duly accredited.

Article 10: Transport

The handling and transporting of PCBs must be carried out according to the conditions laid down in the order of the Ministry of the Environment and defined in annex V.

Packaging used for PCBs can not be reused for any other products and must be disposed of in the same fashion as PCBs.

Article 11: PCB discharges

The transfer is forbidden of any solid or liquid PCBs, as defined in article 1 of the present decree, except for the purpose of technical retrofitting or repair operations as defined in annexes II and IV.

Article 12: Accidents and pollution

In the event of an accident (breakage, explosion, fire, etc.), the owner must immediately inform the appropriate services, which will explain the protective measures to be taken, including the initial steps to minimize the consequences of the accident.

The inspector may require the conduct of the necessary analyses to determine the extent of PCB contamination of the installation and the environment, or, where appropriate, contamination by decomposed products.
In the light of the results of these analyses the technical services of the Ministry of the Environment may require the owner to carry out whatever work is necessary for the decontamination of the areas concerned.
Further specification of these analyses and operations will be provided (by ministerial order) where justified by the scale of the accident.
The operator must keep the inspectorate informed as to the progress of the work and other measures required.
Rubble, earth and other contaminated materials must be disposed of in approved premises.
The conditions under which action is to be taken in the event of PCB pollution are defined in annex VI.

Article 13: Transboundary movements of PCBs

The import of the PCBs defined in article 1 is prohibited.

Equipment that could potentially contain PCBs may only be imported subject to the results of an analysis to be carried out by an independent, duly accredited laboratory at the expense of the exporter. This analysis must show a PCB content of less than 3 ppm.

Transit operations may only be authorized if there is no other viable solution that does not involve a risk of pollution.

PCB exports are only authorized in operations involving the final treatment of PCBs and the decontamination of PCB-containing equipment.

Exports must be carried out in compliance with the provisions of the Basel Convention on the Transboundary Movements of Hazardous Wastes and ratified by … [country].

Article 14: PCB analyses

The Ministry of the Environment shall establish the benchmark methods to be used in determining the PCB content of contaminated materials. Measures implemented prior to the determination of such reference methods remain valid.

Article 15:

The present decree will be published in the **Official Gazette** of [country]……

Done at……. on the ……

7.2 – Comments on the draft regulations

Article 1: It is important to work out an exact definition of PCBs for those products that are not 100% PCB but have a greater than 50 ppm contamination level. This applies, for example, to mineral oil transformers with a dielectric content greater than 50 ppm.

Article 3: This fundamental article regulates commercial transactions, including those at no charge, of PCB-containing equipment. The example given proposes an import ban on PCB-containing equipment.

The article suggests retaliatory methods to be used against those contravening the terms of the said article.

Article 4: This article obliges all PCB owners to declare themselves to the appropriate authorities to ensure the traceability of all PCB installations in the country in question and to implement a projected elimination plan ending in 2013.

Article 5: The purpose of retrofitting existing installations is to prevent pollution that can be caused by active transformers.

Catch basin	To prevent the release of liquid PCBs
Fire-wall	To limit the dispersal of toxic substances
Disconnection mechanism for use if there is any malfunctioning of the appliance	To prevent the risk of any thermal decomposition of the dielectrics and production of toxic gases (PCDD and PCDF).
Sealing of ventilation shafts	To avert the dispersal of toxic gas into the air-conditioning system

Article 6: Retrofilling is forbidden because of the attendant risks of uncontrolled contamination, resulting from the leaching of PCBs impregnated as residues in the operating parts of the transformer.

In any event, retrofilling has no significant effect on the initial PCB content of the transformer.

Article 7: Technical inspection is a legal precondition for the use of PCB transformers, in environmentally sound management conditions, up to the end of their service life.

Article 8: 2013 has been set as the final date for disposal of all PCBs within the country in question. This date has taken into account the 1984 ban on the production and distribution of PCBs in producing countries.

Bearing in mind that 1984 would be the last year of PCB imports and that the average working life of a transformer is 30 years, then the year 2013 would in fact be the end of the time span allowed for the replacement of these appliances.

Article 9: This article, on PCB disposal, is designed to prevent non-controlled procedures for the elimination of hazardous wastes. The specific procedures concerned are scrapping, burning, dumping and dilution, the last of which is already covered in some detail in, for example, the environmental code of Côte d'Ivoire (used as the model here).

Article 10: Although already mentioned in the Ivorian regulations on the transport of hazardous materials, the transport conditions for PCBs must be spelled out in more detail because of the risks arising from their toxicity.

Article 11: It is essential that transfers and deliberate spills designed to evade regulatory constraints should be banned, to prevent the growth of PCBs in ecosystems, not least because of the way they bio-accumulate and are not bio-degradable in the natural environment.

Article 12: The purpose of this article is to define the technical operations to be implemented in order:

- To contain the contaminated area;
- To decontaminate the affected areas, both surface and below surface.

Article 13: These regulatory constraints on the export of PCBs are specifically designed to prevent the illegal transfer for commercial purposes of PCB-containing electrical equipment into the countries of the subregion.

8 – Financial tools for the management and destruction of PCBs

Responsibility for meeting the costs of destroying PCBs should be shared by various stakeholders, including those owning and manufacturing the PCBs. In this context, in developing countries, the electricity production and distribution networks account for a large part, up to 40%, of the national stock of PCBs, because of the level of industrial activity and the consumption of low-voltage electricity. There is no hard and fast rule about how these costs should be shared among the various economic sectors mentioned above. These networks may be completely public, completely private or a combination of the two. Moreover, by reason of their activities, it is the electricity production and distribution companies which hold most of the obsolete PCB stocks.

Any analysis of this problem must also take into account the different attitudes to industrial waste management as seen by the public and the private sectors. Looked at in this way, economic activity can be divided into three different sectors, each showing differing attitudes to the problem of the environmentally sustainable management of PCB-containing equipment:

- The public sector (electricity production, water resources, public transport, telecommunications etc.);
- The national private sector and the private sector dependent on multi-nationals;
- The informal sector.

8.1 – Various economic sectors owning PCB equipment

8.1.1 – Public sector

Despite the enormous difficulties which it faces, the public sector in developing countries is, by its very nature, open to environmental controls and willing to apply them with care. This is because it is not under as much pressure to show results as the private sector.

Managers in the public sector are also receptive to the need to develop clean technology and its associated systems. The PCB problem is a good example, as it was very quickly taken on board in the environmental management of their activities. The public sector's enhanced sensitivity to environmental issues is facilitated by the dissemination of a wide range of information.

The problem, however, will remain unresolved as long as the funding made available to the sector for the management of PCBs remains confidential (for the retrofilling of existing fillings, the replacement of obsolete appliances, the destruction of scrapped appliances). Stocktaking exercises carried out in Africa show that there are stocks of scrapped PCB transformers that have been stored for several years with no special precautions, and these have caused significant levels of soil pollution.

The position taken by the public sector on the funding of PCB management operations is clear: management programmes must be implemented with the support of important bilateral or multilateral financial mechanisms. This does not apply to capacity enhancing alone but also to the whole management of PCBs right up to their final elimination.

8.1.2 – Private sector

(a) The national private sector, inasmuch as it is obliged to produce profits in a competitive context, takes a different approach to the question of hazardous industrial waste. This particular situation encourages lobbying and even economic "blackmail" as a way of evading

environmental obligations. The problem they have is not with the concept of control itself but with the financial impact it has on production costs and competitiveness.
The national private sector is therefore not inclined to support the additional financial costs incurred by PCB management, and PCB transformers are only replaced for reasons of technical efficiency (obsolescence, increased capacity, modernization).

(b) The multinational private sector applies environmental management standards generally supervised by an environmental official and expressed in strict directives laid down by the parent company. This company policy has to be seen within the general context of multinational activity, in which the multinationals are at times called to task for their social and environmental management. The extensive media coverage given to PCBs in industrialized countries has made the relevant officials within the multi-nationals more aware of the significant environmental impact of their industrial activity on developing countries and of its repercussions. In consequence, many multi-nationals are implementing plans for the elimination of PCB transformers and taking responsibility for the cost of these programmes in both financial and human terms.

8.1.3 – Informal sector

The informal sector, although not as directly concerned with the problem of PCB management, must also be taken into consideration when analysing the way PCBs are handled. In the majority of cases businesses within the informal sector buy low-voltage power and rarely use high-voltage electrical fittings. It is unusual for this sector to buy medium-voltage power and transform it down to low-voltage using its own transformers. In such cases step-down transformers are administered by the public or private companies which produce and distribute electricity.

Moreover the informal sector is especially concerned with the recycling of electrical transformers, including the recycling of metals and oil from transformers. An electrical transformer can contain up to 20% of its total weight in copper, and this represents significant market value for a business in the informal sector. The copper is generally reprocessed by open air burning with used tyres so as to produce a resin-less copper. This copper is then sold for recycling, to be used in the production of new equipment.

Another method is to recycle the copper as copper wire, using a simple unwinding process. This process can also be applied to magnetic sheets. While these methods are environmentally sound for mineral oil transformers, this does not apply to PCB-containing equipment, where there are extremely negative impacts on health and environment. Thus, during the burning process, the thermal decomposition of the PCBs at a low temperature produces carbon monoxide, chlorine, dioxins and furans. The oil from transformers can also be recycled as a fuel substitute, hydraulic fluid, moulding oil or for phytosanitary use. PCB oils are thus 100% recycled or else mixed with used oil to be re-sold as fuel or as chemical products for various uses.

In the informal sector, the management of PCB transformers while they are in industrial use causes the problem as the recycling of used electrical transformers. Future financial mechanisms will therefore have to take into consideration the specific nature of these recycling procedures. In this case, to be effective, financial compensation would have to match the returns from the existing recycling process.

8.2 – PCBs and hazardous industrial waste in the private industrial sector

Several factors must be taken into consideration when the concept of hazardous industrial waste is applied to PCBs. These factors underline the difficulties of regulating the use of PCBs in the private industrial sector:

- When these types of equipment were first put on the market, before they were banned, there were no restrictions placed on industries regarding their use or requirements for them to be scrapped. Private sector users are therefore reluctant to accept responsibility for the consequences of regulations laid down subsequent to their acquisition of this equipment. The sector is naturally anxious to avoid having to bear the financial costs of the sound environmental management of this equipment while it is in industrial use until its final elimination.
- The positions taken by the international community, based on the precautionary principle, in, on the one hand, the environmental management of chemical products such as CFCs (Montreal Protocol) and, on the other, the legal campaigns to make asbestos manufacturers retroactively responsible for environmental consequences, lend further weight to the position taken by the private sector in developing countries in ascribing historical responsibility to the industrialized countries. As such, it is difficult to justify the setting up of compensatory financial mechanisms in the industrialized countries if the same is not applied to developing countries.
- Electrical fittings containing PCBs are considered primarily as industrial products and not as hazardous industrial wastes. The concept of industrial waste is part of the development of chemical industries.
- Even if the PCBs contained in electrical appliances are identified as being a hazardous chemical substances, this does not necessarily hold true for the appliance itself. The phenomenon of PCB impregnation into the porous parts of transformers (about 5% of the initial quantity of PCBs) is generally ignored, thus opening up the possibility of trade in second-hand transformers.
- The processing of industrial waste in developing countries is rarely “internalized” and integrated into production costs. If PCBs were to be included on the list of hazardous industrial wastes then financial mechanisms would need to be implemented based on the ‘polluter pays’ principle and, for example, the contribution of funding bodies to the redistribution of the compensatory pollution taxes which would need to be collected.

If the cost of destroying the appliance is imposed unilaterally on its possessor, some of these appliances will not be dealt with in an “environmentally sound” manner. There would be a great risk of a situation where significant numbers of PCBs would be released unofficially into the environment. Industrialized countries have noted during the preparation of inventories that, at the time when PCBs were introduced into environmental law, a significant quantity of appliances with PCBs “disappeared”. These appliances are sometimes exported and re-sold as second-hand transformers in non-industrialized countries. The export of fittings containing PCBs under the label “second-hand transformer” will follow the path of least resistance in countries where the law is incomplete or not implemented, border controls are non-existent, standards of public health are low and also where regulations to enforce responsibility are barely developed. These factors, associated with the high costs of elimination, are the driving force behind such cases of illegal trafficking as defined by the Basel Convention.

The meaningful discussions that have already taken place in certain countries that are party to the Basel Convention have brought to light the necessity for countries to develop targeted approaches, taking into account the aforementioned factors. With this in mind, the reluctance of manufacturers and of non-industrialized countries to finance the destruction of products

imported several decades ago on the basis of their excellent physico-chemical qualities compels us to look for financial solutions that will involve a combination of the public sector, the private sector and external sources.

Accordingly, the national PCB management policy should be a process that involves the owner from the very first stage of the inventory process and allows for the product concerned to be followed and its movements to be tracked by the authorized bodies up to the end of its natural life and its destruction.

8.3 – Possible financial mechanisms

1 – Full implementation of the polluter pays principle
This is the position generally adopted by the multinationals who support the whole financial burden of PCB management on their industrial sites. This situation explains, to a large extent but not completely, the transboundary movements of PCBs from developing countries to industrialized countries[11]. This mechanism, however, cannot be implemented in the private sector at the national level without at the same time causing the emergence of informal recycling procedures that are inexpensive and not controlled (informal).

2 – Enforcement of the historical responsibility of the manufacturer
The 'polluter pays' principle cannot be clearly established in this case because it applies more to the user of the chemical product than to its manufacturer. For example, the treatment of perchloroethylene sludge used in dry cleaning is the responsibility of the user. Recent market developments allow businesses to include in their services the recovery of perchloroethylene sediment, with the cost of elimination provided for in the selling price. As for PCBs, the manufacturers claim that this substance has made for a considerable increase in the fire safety of mineral oil transformers in an urban environment, thereby contributing to the environmental protection of the urban habitat.

3 – Levying an eco-tax on new transformers
This mechanism is increasingly being used for widely distributed industrial products such as tyres and batteries of various kinds. It could be applied to all production and distribution businesses importing electrical fittings in developing countries.

4 – Levying an eco-tax on KWh
If a long period, e.g., 20 years, is anticipated for the total elimination of PCBs, this financial mechanism would be of some interest as it would allow for a return in the costs of PCB management to be recouped over the same period. There is the possibility that fees could be charged at the municipal level by the company distributing energy, and funds provided to support the costs of managing municipal waste.

5 – Multilateral financing
The principle of multilateral financing has been introduced into the financial mechanisms of the Stockholm Convention. The amount of time needed for their implementation could be detrimental to the sound management of PCBs, leading to the existence of obsolete and, in many cases, orphan stocks, necessitating short-term action.

6 –Tied loans
These mechanisms are widely used in industrialized countries and link the 'polluter pays' principle with environmental responsibility on the part of the industries that generate industrial

[11] For this refer to the compilation of national reports prepared by the secretariat of the Basel Convention.

waste. Under an agreement between the producer or owner of industrial waste and a national environmental agency, the industry can benefit from financial mechanisms for the processing of its industrial waste in return for an undertaking to ensure the proper environmental management of its industrial activity. These mechanisms can be implemented as loans or in the form of participation in financing the costs of processing hazardous industrial waste. They have the advantage of creating awareness within the industry generating the industrial waste by the implementation of environmentally sound waste management

When applied to PCBs, this type of financial mechanism can also have an educational effect insofar as it allows the concept of environmentally sound management to be introduced into industrial activity and extends this sense of responsibility beyond PCBs alone.

Seen in this light, a financial agreement could be envisaged, managed by a governmental agency, which would commit the owner to certain obligations throughout the industrial life of the appliance until its final destruction:

- Obligation to declare ownership of a PCB appliance
- Obligation to install it properly
- Obligation to have the appliance destroyed at an authorized installation when it is time for it to be scrapped

The 'polluter pays' principle has already been introduced into the environmental law of many countries, but even so PCB owners are loath to accept the principle, for the following reasons:

- The difficulty of classifying an industrial product such as a transformer as a hazardous waste;
- A working transformer does not become waste until it is scrapped.

8.4 – Estimate of the costs of managing and eliminating PCBs

The evaluation of these costs covers all operations involving PCB transformers from declaration of ownership to final elimination.

Technical control:

- Dielectric analysis (water content, breakdown voltage, etc.);
- PCB screening of mineral oils;
- Site evaluation (inflammable products, ventilation, laying of cables, presence of PCBs and mineral oil - see inventory questionnaire).

Retrofitting:

- Physico-chemical treatment of the dielectrics or replacement;
- Installation of holding tanks, gas detection and temperature and pressure control systems, installation of firewalls or removal and replacement of the PCB.

Evaluation of the costs of management, treatment and elimination

Evaluation of costs for a transformer - average weight 2,200 kg - estimated amount of PCBs (30%). 660 kg	US $
Technical control of an existing installation	350
Retrofitting (catch basin, DGPT9)	800
Servicing costs (four inspections every 12 years)	600
Handling and transport to the storage area	100
Storage costs (max. 1 year)	250
Costs of the transport and elimination of PCB liquids (660 kg at 2.5 US$ per kg)[12]	1 650
Costs of the decontamination of contaminated equipment shells (1,540 kg at 0.8 US$ per kg)[13]	1 232
Total	4 982
Total/tonnage of fittings	2 270

The replacement of the appliance is not taken into consideration since this depends purely on its age and has nothing to do with whether or not it contains any PCBs.

8.5 – Mechanisms for tied loans

When applying for partial or total financing of the costs of management and elimination, the eligibility of owners would be subject to the mandatory requirements set out in the regulations:

To declare all PCB-containing appliances in or out of use;
To retrofit all installations in use, according to the requirements set out in the regulations;
To ensure that servicing is carried out up to the time of scrapping;
To make sure that fittings containing PCBs are eliminated at the due date for scrapping.

Funding of this agreement could be of a mixed nature, as follows:
One part self-financing on the part of the owner, at the level of 20% (…);
Eco-tax imposed on the consumption of electricity;
Contribution by multilateral funding mechanisms;
Contribution by the equipment manufacturers[14].

[12] Initial forecast based on current known situation and prevailing conditions; elimination by incineration at specialized overseas sites (Europe, North America etc.).

[13] Initial forecast based on decontamination of equipment shells carried out locally with assistance of technology transfer.

[14] This solution is not elaborated in detail here, but the manufacturers of electrical equipment could submit tenders for the recovery or processing of existing equipment when it is due to be replaced;

Financial scenario in US dollars (by way of example)
(consumption of electricity: 2,400,000,000 kW-1,000 T)

Tonnage for processing by 2013	1,000 tons	
Overall costs (at 2,270 US$ per ton)[15]	100 %	2,270,000
GEF financing (forecast 30%)	30%	681,000
Self-financing by the owner (estimate 20%)	20 %	454,000
Ecotax on the consumer price (forecast 50%)	50 %	1,135,000
Ecotax rates (forecast 50%)	0,00004729 US$/kW	
Taxable consumption per ten years	24 000 000 000 kW	
Taxable consumption per year	2 400 000 000 kW	

Operational modalities for tied loans

- The loan agreement is to be signed by the owner and the funding body;
- This agreement cannot enter into force until the owner has complied with the technical obligations of making a declaration and retrofitting following the initial technical inspection;
- The expenses involved are to be submitted to the funding body in the form of a quotation which will be included in the financing agreement;
- The body designated to manage these agreements will receive for each signed agreement the corresponding pollution compensation fees and financial support from GEF;
- The owner will pay the agency its share of the self-financing over a period of five years, per appliance and per year (scaled according to weight);
- The expenses to be incurred under this agreement are to be paid by the funding body to the various suppliers involved in this agreement, which should enable the funding body to issue calls for tender in major markets.

As part of the approval process, the funding arrangements should be subjected to a specific study which would take account of different scenarios such as:

- The distribution of pollution compensation fees levied for the overall consumption or the industrial consumption of electricity;
- Self-financing contribution by the owners;
- Financial support contributed by GEF.

[15] Administrative, project management and funding costs etc. are not included in this calculation. The calculation is made in real money values.

Annexes

I: PCB declaration form

II: Retrofitting

III: Labelling

IV: Repairs

V: Instructions on the handling and transport of equipment and materials

VI: Instructions on the storing of PCBs due for elimination

VII: Instructions on hot and cold pollution

VIII: Toxicity of PCDDs and PCDFs

IX: List of trade names by country

X: Glossary and abbreviations

XI: Stockholm Convention – articles and annexes

XII: List of contacts

XIII: References

Annex I – PCB declaration form

INFORMATION ON THE COMPANY

Date of declaration	
Name of company	
Address 1	
Address 2	
Town or city	
Postal code	
Contact	
Position	
Type of business	
Tel.	
Fax	
Email	

TECHNICAL INFORMATION ABOUT THE APPLIANCE	Tick the relevant box
Transformer	
Capacitor	
Drums	
Manufacturers	
Power (kVA)	
Date of manufacture	
Age of transformer	
Dielectrics identified as 100% PCB	
Dielectrics identified as mineral oil > 50 ppm	
Dielectrics identified as mineral oil < 50 ppm	
Retrofilled transformer	
Dry transformer	
Not determined	
Serial number	
Total weight in kg	
Dielectrical weight	
Commercial name of the dielectric	
In use	
Stand-by	
In storage prior to destruction	

SAFETY	YES	NO
Lack of PCB warning signs on the equipment		
PCB warning signs in the workshop area		
PCB warning signs outside the premises		
PCB warning signs (equipment, in premises, outside premises)		
Volume contained > PCB volume		
Volume contained < PCB volume		
Lack of retention devices		
SERVICING		
Inspections at intervals of less than one year		
Inspections at intervals of between one and three years		
Inspections at intervals of more than three years		
Not determined		
Checking of dielectric fluid		
Checking of insulation		
Analysis of dielectrics		
Fault detector for gas, temperature, pressure		
Short circuit protection		
Gaseous phase chromatography		
Gaseous phase chromatography (result)		
Breakdown voltage		
Acidity test		
Presence of PCBs and mineral oil on the same site		
Connections to air-conditioning systems		
Adequate ventilation in the workshop		
Access restricted to authorized personnel		
Apparent leakage of dielectrics		
Contaminated soil		
Taking oil samples		
Oil contamination level		
No samples taken		

Comments:	

Annex II – Retrofitting

Every precautionary measure should be taken to avoid even the slightest risk of fire. To this end, the PCBs should be stored far away from any inflammable substance. All deposits of pollutants and appliances impregnated with PCBs should be fitted with watertight devices to prevent discharges, with a capacity greater than, or at least equal to the highest of the following values:

- Existing installations: the existing retention system can be retained if it is watertight and if its overflow is not likely to seep into the natural environment or the public sanitation network;

- New installations: the device must have a capacity which is at least equal to the highest of the following values:

    - 100% of the capacity of the largest container;

    - 50% of the total stored volume (a site containing a transformer holding 400 litres of pyraline and two other transformers with a capacity of 300 litres must have a retention capacity of at least 500 litres).

Stocks should be kept in hard-wearing receptacles and should be clearly marked. All PCB-containing appliances should be labelled. For existing installations which have mineral oil appliances and PCB-containing appliances at the same site, a two-hour rating firewall must be erected (high ceilings, vertical partitions, etc.); potential communication channels with other sites must be fire-proofed to at least one-hour rating. As the opening faces the exit the doors must be strengthened.

Preventative measures must be taken to minimize the probability and the consequences of accidents that might cause a release of toxic substances (one of the main causes of these accidents is a fault in the electrical protection of individual pieces of equipment upstream or downstream of the appliance. Thus excessive internal pressure on the equipment, possibly produced by an electrical fault, can cause a breach that then leads to a release of PCBs: it is essential to prevent arcing which might start a fire).

Electrical equipment containing PCBs must conform to the standards in force at the time of installation. Arrangements for the protection of individual appliances must also ensure that the appliances cannot be automatically switched back on. Instructions must also be given to prevent the equipment being manually re-started before the fault has been identified.

A trouble-shooting mechanism for the detection of gas, temperature and pressure faults must be installed in every appliance in use. The user must take all the constructive precautions available on site to avoid the circulation into offices or inhabited areas of any accidental release of vapours from the dielectric. Above all these vapours must not be allowed to reach any waste-removal or ventilation pipes or shafts not exclusively used by the workshop. When the shafts used by the workshop provide access to other areas, such as those mentioned above, then they must be equipped, at the connection points, with a watertight, pressure-resistant plug.

When the workshop is accessible from a private, enclosed space that itself leads to the above-mentioned pipes or areas, then it is especially important that the connecting door be watertight and pressure-resistant. Thus, transformers containing PCBs are considered to be properly protected when one of the following measures is implemented:

- Basic protection, provided by power-calibrated fuses;
- Instant voltage shut-off in the event of excess pressure, the detection of gaseous bubbles or a drop in the dielectric level.

The user is permitted a designated period of X months in which to complete the necessary inspections of the equipment and X years from the designated date to finish retrofitting the equipment according to the standards set out above.

Annex III - Labelling

Labelling of PCB appliances

All appliances containing or having once contained PCBs must be marked with labels carrying the following information:
This appliance contains PCBs which can contaminate the environment and which by law have to be eliminated.
Decree No. […]
Labelling of decontaminated appliances that have contained PCBs

Each unit of the decontaminated appliance must be clearly and indelibly marked by embossing or stamping with the following information

Decontaminated PCB-containing appliance PCB-containing liquid has been replaced by: By ..... (name of substitute) On ..... (date) By ..... (company) PCB concentration: In the former liquid content..... % by weight In the current liquid content..... % by weight

Annex IV – Repairs

While waiting to be decontaminated, discontinued or eliminated in compliance with current legislation, the servicing of PCB-containing transformers can only be continued if the objective is to ensure that the PCBs they contain meet the correct technical standards or specifications with regard to their dielectrical properties and on condition that the transformers remain in good working order with no leakages. The only repairs authorized are those that do not necessitate partial or total draining of the electrical equipment in question.

Any electrical equipment which has been through this process before the publication of the present decree will henceforward be deemed to be PCB-containing and as such, be subject to the same technical obligations.

With the electrical equipment designated in paragraph 1 above, however, certain oil-level readjustments can be permitted. These adjustments can only be made, however, with oil that is technically compatible.

PCB-containing wastes produced in the course of operating the equipment (servicing, filling, cleaning, etc.) will be first stored and then eliminated in environmentally friendly conditions in installations that, in all cases, are duly authorized for this purpose. The user may be required to provide due substantiation of this at any time.

When maintenance or repair work is being carried out on site, involving the handling of PCB-containing appliances, or the topping-up or treatment of PCB dielectrics, the user must take the necessary precautions to prevent any risk of pollution resulting from these operations.

Annex V – Instructions on the handling and transport of equipment and materials

PCB wastes as defined by this decree and designated for elimination are subject to certain standards with regard to packaging and transportation. Liquid wastes must be placed in closed drums and solid wastes in open-top drums.

Specifications for drums:
2001: closed drums

Filling level: 90%
Marking of drums as per UN specifications;
1: containers /A: Steel
1: non-detachable (sealed) –2: detachable
Y: packing group II et III
For liquids: density: 1.5
For solids: maximum gross weight
Value in kPa of hydraulic test pressure: (> 100 kPa)
Year of manufacture of packaging:
Sample of liquid PCBs in sealed containers: 1A1 Y/1,5/150/83
PCB liquid wastes must be packed in sealed containers and PCB solid wastes in completely open containers
The containers must be palleted and secured on the pallets
The containers and metal cases must be labelled so as to show the relevant UN category and code

UN Code		Safety sheet information
Group N°:	90 201	Chlorine content: from 42 to 60%
UN Code:	2315	Melting point: -19
IMO class: 9	9	Evaporation temperature: 325°
Packaging group II		Flash point: 176°:
Parcel labelling: 9		Density. 1.5
IMDG code PCB		

Transport

The transporter must be given an itinerary form which should indicate the nature and quantity of the products being transported. The vehicle must be provided with the regulation signs (hazardous materials plates)

- No inflammable product should be transported
- The drivers of the specially equipped vehicle must be informed of the nature of the goods being transported and their associated hazards
- The drivers must have at their disposal the regulation signs and protection equipment, a 9 kg dry-powder fire-extinguisher, sufficient quantities of absorbents to soak up any PCB leakage
- The drivers must know exactly what they are carrying and trained so that, in the event of an accident or incident, they will be able to avoid the danger of fire, heat pollution, spillages, the dispersion of PCBs into the environment, and cold pollution;
- The driver must be familiar with the first-aid procedures applicable to PCBs
- A safety disk must be affixed to the vehicle
  The owner should deal solely with specialized companies duly authorized to carry out transport operations of this type

Required protection equipment for the handling and transport of PCBs:

- Disposable overalls
- PVC glasses and gloves
- Overshoes

Preventative materials:

- Breathing mask with a special cartridge for chlorinated products
- Inert absorbent bags
- Signalling tape

PCB TRANSPORT FORM

MANUFACTURER

Company	
Address	
Person in charge	
Position	
Tel/fax/e-mail	
Designation of waste	
Quantity	
Packaging	
Number of appliances	
Number of containers	

Signature of manufacturer

TRANSPORTER

Company	
Address	
Person in charge	
Position	
Tel/fax/e-mail	
Date of shipping	
Delivery date	

Signature of transporter

CONSIGNEE

Company	
Address	
Person in charge	
Position	
Tel/fax/e-mail	
Delivery date	

Signature of consignee

Five copies of the form are drawn up:

Copy no.1: for the manufacturer
Copy no.2: for the transporter
Copy no.3: for the consignee
Copy no.4: for the manufacturer, dated and signed by the consignee
Copy no.5: for the classified installations inspectorate (or equivalent service)

PCB-containing equipment destined for scrap must be carefully drained prior to being stored or transported.

The contents must be decanted into watertight receptacles.

Annex VI – Instructions on the storage of PCBs prior to their elimination

PCBs must be stored in accordance with the following conditions:

- The site must be adequately ventilated and sheltered from bad weather and the risk of fire
- Absolutely no inflammable products should be present either on the site itself or in the vicinity
- The floor must be watertight or equipped with a catch basin with a capacity greater than the volume of PCB liquid on the site
- The site must be locked and subject to regular, duly logged inspections
- Signs reading “Danger PCB” must be put up inside and outside the site
- A complete inventory must be made and regularly updated of all incoming and outgoing items
- The person responsible for stocktaking must have the necessary qualifications
- Liquid waste must be kept in regulation containers
- Prior authorization for the storage site must be obtained from the classified installations and civil protection inspectorate, or equivalent service. This authorization will specify, among other things:

    - the maximum amount of equipment that can be stored
    - the maximum time a consignment can be stored between admission and discharge
    - inventory particulars (incoming to be provided by the manufacturers and outgoing by the consignees)

Annex VII – Instructions on hot and cold pollution

COLD POLLUTION WITHOUT THERMAL DECOMPOSITION

- In the event of a release of PCBs and a risk of environmental contamination, alert the classified installation and civil protection inspectorate (or equivalent service)
- Alert the doctor on duty and provide the staff with PCB protective clothing: wrap-around glasses, gloves and/or overshoes, breathing mask fitted with a filter cartridge
- Mark out a safety perimeter and, where necessary, ventilate the site in every way possible
- Contain the PCB dispersion by sealing off the leak (with cloths, cling-film, etc.) and with the use of inert absorbents
- Clean the soil

Watertight flooring

- Scrape down thoroughly using rags soaked in solvent
- Under no circumstances use a naked flame. Do not use chlorinated solvent, but rather mild detergents such as washing-up liquid..

Non-watertight flooring

- Remove the heavily contaminated layers: concrete, earth etc.
- If there is any risk of contamination to groundwater, urgent steps must be taken to limit, settle and eventually eliminate the pollution
- Gather up all the polluted products (washing water, earth with a more than 100 ppm level of pollution, clothes etc.) and store them in watertight containers for eventual incineration on an authorized site to be agreed.

Soil decontamination standards

- Materials over 100 ppm must be treated
- Materials between 10 and 100 ppm can be disposed of in approved landfills or contained on site
- Materials under 10 ppm are considered uncontaminated
  Washing water cannot be thrown out unless it has a content of less than 0.5 µg per litre.

HEAT POLLUTION RESULTING FROM BREAKS IN THE TANK AND THERMAL DECOMPOSITION

- Disconnect the power without entering the premises;
- Call the fire brigade, giving them details of the nature of the accident to ensure that they bring the appropriate equipment to gain entry to the premises and to fight the fire. (The use of water should be avoided because it might cause the catch basins to spill into the surrounding environment; CO_2 or dry ice would be preferable);
- Inform the competent authorities immediately;
- Prohibit access to the polluted area to any persons not wearing protective clothing (waterproof overalls, glasses, mask, overshoes) and access must be allowed only when strictly necessary and for short periods of time;
- Limit the extent of the pollution by sealing off any possible channels of transmission between polluted and non-polluted areas;

- Check the extent of contamination;

- On appraisal of the results of these analyses the classified installations inspectorate may order the manufacturer to carry out various procedures essential to the decontamination of the affected areas, namely:

    - To dump rubble, objects of little value and contaminated clothing in a container for subsequent incineration at an approved site;
    - With the use of steam or solvent, to clean fixed surfaces and objects of value so as to eliminate surface contamination and appreciably reduce the general level of contamination with a view to re-opening the site and eventually bringing it back into use.

Annex VIII – Toxicity levels of PCDDs and PCDFs

Although there is a large body of scientific literature on the subject of the experimental toxicity of PCDDs and PCDFs, it is still difficult to say exactly how long the effects of such contamination remain in the human body. Essentially it is the knowledge acquired after the Seveso accident of 1976 or the contamination of Times Beach (Missouri) in 1971 that makes it possible, with hindsight, to understand the consequences of acute or prolonged contamination by 2.3.7.8 TCDD, but it would be arbitrary to extrapolate from this, with no adjustment, the consequences of risks from thermal deterioration of PCBs. Indeed, when it was possible to measure it, 2.3.7.8 TCDD was present in minuscule quantities.

It is true that some authors, seeking to establish the exposure threshold values as guides to decontamination, have put forward the idea of a *2.3.7.8 TCDD equivalent* for the different isomers of PCDD and PCDF, but this is still only a theory, based on the comparative level of DL 50 with laboratory animals. Thus, 2.3.7.8 TCDF would be three times less toxic than 2,3,7,8 TCDD. Much higher toxicity levels can be seen among quite close isomers: (ratios above 10,000 between DL 50 of 1.2.3.8 TCDD and 2.3.7.8 TCDD.) As a general rule the most toxic derivatives are isomers containing 4-6 atoms of chlorine with lateral positions 2.3.7.8 substituted. Despite its usefulness for the purposes of taking decisions, the notion of *2.3.7.8 TCDD equivalence* remains questionable as the ratio between DL 50 of two derivatives such as 2.3.7.8 TCDD and 2.3.7.8 TCDF differs depending on the species in question.

Humans, like other species, absorb contamination mainly through the skin and the digestive system. The bio-accumulation of different PCDDs and PCDFs in the fatty tissues of an organism is evidence of the cumulative quality of toxic effects. Using epidemiological data taken from different instances of human contamination, compared with experimental data on animals, we can identify several possible areas of biological impact.

1. Skin disorders

Here we are dealing essentially with chloracnes, which reproduce easily in animals. Chlorachnes have been found in humans after brief but intense periods of contamination; the best example of this is in Seveso where several observations have been made:

- The effect of chlorachnes on children is greater than on adults, at the same level of contamination;
- There can be a delay of up to 10 months before the effects appear;
- The intensity of the chloracne and the speed with which it takes hold are directly related to the levels of contamination.

Additional cutaneous symptoms (rashes, hyperpigmentation, oedemas,) and mucous conditions (conjunctivitis) are present in Yusho disease. Chlorachne can last for a particularly long time: after an instance of industrial exposure where 79 employees developed chlorachne, follow-up tests 10 years later showed that cutaneous symptoms still persisted among half the victims.

2. Liver disorders

Experiments on animals and massive levels of industrial contamination in the case of humans lead us to expect the dioxins will have a toxic effect on the liver. In Seveso enlargement of the liver (hepatomegalia) was observed in 7-8% of adults in the most exposed area. The exact nature of the liver disorders has not been clearly defined and there has been no systematic research into enzyme induction. A case-study of 427 persons in the exposed area and 563 persons in a neighbouring town did not show any significant difference in the number of hepatic changes in those who had been exposed.

3. Neuro-muscular effects

Few experimental studies demonstrate the likelihood of any neurological or muscular effects. Some forms of myalgia, ataxia and swelling of the joints have, however been noted in occupational exposures. The interpretation of clinical data and electro-physiological tests carried out in Seveso has given rise to some controversy: it appears that the slowing down of the motor nervous system observed in some subjects who had been exposed was no more than an acceptable variation within the normal range.

4. Other visceral disorders

Some haemorrhagic cysts were observed in studies carried out of the contamination in Times Beach, Missouri. The statistics have neither been explained nor confirmed but they do warrant systematic research into microscopic haematoria in persons exposed to such products. A range of functional symptoms including asthenia, insomnia, headaches and digestive troubles have also been noted, in particular in Yusho disease.

5. Immune system disorders

Experiments on animals have drawn attention to immuno-depression linked to 2.3.7.8 TCDD, which in certain colonies of mice has caused both humoral and cellular depression with atrophy of the thymus; 2.3.7.8 TCDF appears to have a 30 times lower immuno-depressive effect on the mice. As for humans, both qualitative and quantitative lympho-cytic tests were carried out on a subgroup of children exposed to the contamination at Seveso without any evidence being found of the anomalies expected from the animal studies on toxicity. There was no increased susceptibility to infection among the exposed group in the months following the contamination. In the study carried out at Times Beach, cellular immunity was measured by cutaneous tests of delayed sensitivity, lympho-cytic subgroups and reaction to lympho-cytic proliferation in mitogenes. No significant changes were noted.

6. Metabolic disorders

- Changes in the lipid metabolism with a heightened level of whole lipids and triglycerides were reported in the first studies published of human occupational exposure. They were not encountered at Seveso or Times Beach.

- Experiments show PCDDs to be powerful enzyme conductors, especially in terms of their aryl hydrocarbon hydroxalyse (AHH) inducing potential. The liver enlargement effects noted after the Seveso accident could perhaps be linked to this mechanism but, in the absence of biochemical induction tests that are reliable and easy to implement, this must remain in the realm of conjecture. The level of urinary D-glucanic acid as an indication of enzyme induction is still being appraised.

- Disturbances of porphyrin metabolism by PCDDs are well known in animals, with a rise in the urinary heptacarboxyporphyrin. Cases of cutaneous porphyria in humans have been noted after significant occupational exposure. Among those of the Seveso group who had a chlorachne, however, no anomalies were noted in the urinary excretion of porphyrins. There is a particular interest in the identification of heptacarboxyl porphyrin among the urinary uroporphyrins.

7. Reproductive problems and foetal abnormalities

Experimental studies on animals suggest that TCDD can be foeto-toxic and teratogenic: in the case of monkeys, for example, a species highly sensitive to TCDD, the rate of spontaneous abortion was higher in the group receiving 1 microgram per kg of TCDD than in the control group, although the evidence is not definitive. Among humans, a study of miscarriages did not

show any abnormal increase in the six months following the Seveso exposure. Perinatal mortality also appears not to have increased as a result of the toxic accident. Another epidemiological study on the rate of miscarriages after a leakage of herbicide 2.4.5.1 – containing 2.3.7.8 TCDD impurities – into a forested region of Canada does show, on the contrary, a much higher figure in the exposed region than in the control area.
Congenital abnormalities linked to TCDD administered in doses of from 1 to 3 micrograms per kg have been found in experiments: cleft palates in mice, kidney deformities in mice and rabbits, cardiac deformities in chicken embryos. The epidemiological surveys carried out in Seveso have not demonstrated any increase in congenital deformities, as compared with normal statistics gathered by the same methodology.

8. Carcinogenic and cytogenetic effects

Short-term tests in vitro and in vivo have produced conflicting results concerning the genotoxicity of TCDD, and cytogenetic studies of the lymphocytes of workers exposed to TCDD show no increase in the frequency of chromosomic aberrations. Carcinogenetic experiments on rats and mice show that, after being given mild doses of TCDD, they suffer an increased incidence of thyroid nodules and liver tumours. TCDD is the main cause.

Many epidemiological studies have been carried out on human beings exposed to TCDD. Out of seven studies published on employees subject to occupational exposure only one shows a rise in deaths from cancer, particularly of the gastric kind. The increase in deaths from liver cancer observed by Vietnamese doctors in the civilian population exposed to Agent Orange (a mixture of herbicides: 2.4 D and 2.4.5 T, containing TCDD impurities) has not been proved epidemiologically.

Swedish studies have pointed to an increase in the frequency of soft tissue sarcomas among railway workers handling the same type of herbicides. These results are contested, as subsequent studies have not found this association. The long term follow-up of the population that was exposed in Seveso has not shown any increase in the cancer mortality rate, but it is still only nine years since the incident. For the time being, there is still no real proof that TCDDs have a carcinogenic effect on humans.

Accordingly, it would seem that, apart from chlorachne, metabolic induction and perhaps certain types of cutaneous porphyria, TCDD has not resulted in any really worrying pathology in people subjected to occupational or environmental exposure, of either an organ failure or involving medium or long-term effects. In particular, there is no evidence of ill-effects on offspring of the induction of cancer. In the absence of any definite appraisal of the risks to humans of this kind of product and according to the published statistics from experiments carried out, it would be as well to establish a medical surveillance system, to examine people exposed to PCDD and PCDF.

This system must employ epidemiological methods by introducing a control group, which will facilitate the subsequent interpretation of results:

1. Attribution of exposure levels by synthesizing data from the questionnaire based on the criteria for exposure and the data on toxicology (at the very least, the serum PCB levels; at best, the relative blood and fat levels of PCDDs and PCDFs);

2. Initial clinical examination, repeated at 6 and 12 months intervals and then annually, concentrating on the outer skin, neurological tests, measurements of the liver and the frequency of recurring infections;

3. Complete medical history: Gamma-Glutamyl-transpeptidase (Gamma GT), serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT) (± urinary glucaric acid), lipid profile, tests for microscopic haematuria, urinary porphyrins, examination of the immune system: delayed immunity tests, lymphocyte typing, functional study of lymphocytes.

Annex IX – List of trade names by country

Trade names	Manufacturer/distributor
Abuntol	American Corp, USA
Aceclor	France
Acooclor	AGEC, Belgium
Adine	France
Apirolio	Italy
Apirolio	Caffaro, Italy
Aplrolio	Caffaro, Italy
Apirorlio	Italy
Aroc (h) lor 1221, 1232/1248	Monsanto,USA
1254,1260,1268 1270,1342	PR Mattory 4 Go,USA
2565/4465/5460	United Kingdon, Japan
Aroclor	UK, USA
Asbestol	Monsanto, USA
Askarel	UK, USA
Auxol	Monsanto, USA
Bakola 131	USA
Bakolo (6)	Monsanto, USA
Bromkal	Germany
C (h) lophen A30	Bayer, Germany
C (h) lophen A50	Bayer, Germany
Chloresll *	
Chlorextol	Allis-Chalmers, USA
Chlorinol	USA
Chlorintol	Sprayue Electric Cos, USA
Choresil	
Chlorextol	Allis-Chalmers, USA
Chlorphen	Jard Corp, USA
Clophen	Bayer, Germany
Cloresil	Italy
Clorinol	
Delor	
Diachlor	Sangano Electric
Diaclor	USA
Diaclor	USA
DI (a) conal	
DK(deoachlorodiphenyl)	Caffaro, Italy
DP3,4,5,6,5	
Ducanol	UK
Dykanol	Cornell Dubilier, USA
EEC-IS	Power Zone Transformer,USA
E (d) ucaral	Electrical Utillties Corp, USA
Elaol	Bayer, Germany
Electrophenyl	PCT, France
Electrophenyl T-60	France
Elemex	McGraw Edison, USA
Eucarel	USA
Fenchlor	Italy

Fenclor 42,54,54,70	Caffaro, Italy
Firemaster	USA
Flammex	UK
HFO 101	UK

Trade names	**Manufacturer/distributor**
Hywol	Arovoc, Italy/USA
Inclar	Caffaro, Italy
Inclor	Italy
Inerteen 300,400,600	Westinghouse, USA
Kanechlor	Japan
Kaneclor	Japan
Leromoll	Germany
No-Flamol	USA
Phenoclor	France
Plastivar	UK
Pydraul	USA
Pyralene	France
Pyranol	USA
Pyroclor	UK
Saft-Kuhl	USA
Santothern	France, UK
Solvol	Russian Federation
Therminol	France, USA

Annex X – Glossary and abbreviations

Key words and definitions

Bioaccumulation:
Property of certain substances to accumulate in living organisms.

Biodegradation:
Decomposition of certain substances by living organisms (e.g., bacteria).
Biodegradation is one of the most important processes in the elimination of wastes.

Dielectric:
Substance which does not allow the passage of an electric current through it; non-conducting. Synonym: insulation.

Lethal dose:
Necessary and sufficient quantity of a toxic substance to cause death.

Isomer:
Compounds with the same molecular formula but with different properties due to the atomic structure of the molecule.

Mutagenesis:
Introduction of changes in a cell as a consequence of the action of chemical and physical agents.
In biology, a mutation is an abrupt and permanent alternation in hereditary characteristics caused by changes in the number or properties of the genes.

Permittivity:
Property of a dielectric to reduce the strength of an electrostatic force, expressed as a ratio of its potential in a vacuum. System for measuring this reduction (Example: permittivity of water is 80).

Pyrolysis:
The disassociation of a chemical compound into its constituents under the effect of heat (without oxidation). Synonym: thermolysis

Retrofilling:
Operation consisting in the draining of a transformer of its PCBs, which may or may not be followed by decontamination, and its refilling with a substitute fluid; decontamination is defined as an operation to ensure a sustainable level of PCBs in a fluid of below 50 ppm.

Teratogenic: Said of substances which, through their action on the embryo, may cause congenital malformations.

Abbreviations

Scientific and technical terms:
AHH: aryl hydrocarbon hydroxalyse
CFC: chlorofluorocarbon
EDF: Electricité de France, French electricity supply company
CPG: gas chromatography
Gamma GT: gamma-glutamyl-transpeptidase
LIHT: designates category of halogenated liquid insulators for transformers (standard NFC 27-120)
PCB: polychlorobiphenyl
PCDD: polychlorinated dibenzodioxin
PCDF: polychlorinated dibenzofuran
PCDP: polychlorinated diphenyl.
PDMS: more commonly referred to as silicon oil, this is a mixture of polydimethylsiloxanes, of a viscosity of around 50 centistokes
PCN: polychlorinated naphthalene
PCT: polychlorinated terphenyl
SGOT: serum glutamic oxaloacetic transaminase
SGPT: serum glutamic pyruvic transaminase
TCBT-T: designates the commercial product "Ugilec-T", composed of 60 % tetra-chlorobenzyltoluene (TCBT), which itself goes by the trade name "Ugilec 141", and 40 % trichlorobenzene
TCDD: tetrachlorodibenzodioxin
TCDF: tetrachlorodibenzofuran
ppm: parts per million or milligrams per kilogram
ppb: parts per billion or milligrams per metric ton
1 mg PCB / kg = 1 ppm PCB
1 ng PCB / kg = 1 ppb PCB
1 % PCB = 10 000 ppm PCB
100 % = 1 000 000 ppm

Organization acronyms etc.:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road
CSC Convention: International Convention for Safe Containers, also: Container Safety Convention
GEF: Global Environment Facility
IMCO: Intergovernmental Maritime Consultative Organization (superseded by International Maritime Organization)
IMDG: International Maritime Dangerous Goods Code
IMO: International Maritime Organization
ISO: International Organization for Standardization
NSA: National Standards Association
RID: Regulations concerning the International Transport of Dangerous Goods Rail

Annex XI –Stockholm Convention: Relevant Articles and annexes

Article 3

Measures to reduce or eliminate releases from intentional production and use

1. Each Party shall:

   (a) Prohibit and/or take the legal and administrative measures necessary to eliminate:

      (i) Its production and use of the chemicals listed in Annex A subject to the provisions of that Annex; and

      (ii) Its import and export of the chemicals listed in Annex A in accordance with the provisions of paragraph 2; and

   (b) Restrict its production and use of the chemicals listed in Annex B in accordance with the provisions of that Annex.

2. Each Party shall take measures to ensure:

   (a) That a chemical listed in Annex A or Annex B is imported only:

      (i) For the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6; or

      (ii) For a use or purpose which is permitted for that Party under Annex A or Annex B;

   (b) That a chemical listed in Annex A for which any production or use specific exemption is in effect or a chemical listed in Annex B for which any production or use specific exemption or acceptable purpose is in effect, taking into account any relevant provisions in existing international prior informed consent instruments, is exported only:

      (i) For the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6;

      (ii) To a Party which is permitted to use that chemical under Annex A or Annex B; or

      (iii) To a State not Party to this Convention which has provided an annual certification to the exporting Party. Such certification shall specify the intended use of the chemical and include a statement that, with respect to that chemical, the importing State is committed to:

         a. Protect human health and the environment by taking the necessary measures to minimize or prevent releases;

         b. Comply with the provisions of paragraph 1 of Article 6; and

         c. Comply, where appropriate, with the provisions of paragraph 2 of Part II of Annex B.

The certification shall also include any appropriate supporting documentation, such as legislation, regulatory instruments, or administrative or policy guidelines. The exporting Party shall transmit the certification to the Secretariat within sixty days of receipt.

(c) That a chemical listed in Annex A, for which production and use specific exemptions are no longer in effect for any Party, is not exported from it except for the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6;

(d) For the purposes of this paragraph, the term "State not Party to this Convention" shall include, with respect to a particular chemical, a State or regional economic integration organization that has not agreed to be bound by the Convention with respect to that chemical.

3. Each Party that has one or more regulatory and assessment schemes for new pesticides or new industrial chemicals shall take measures to regulate with the aim of preventing the production and use of new pesticides or new industrial chemicals which, taking into consideration the criteria in paragraph 1 of Annex D, exhibit the characteristics of persistent organic pollutants.

4. Each Party that has one or more regulatory and assessment schemes for pesticides or industrial chemicals shall, where appropriate, take into consideration within these schemes the criteria in paragraph 1 of Annex D when conducting assessments of pesticides or industrial chemicals currently in use.

5. Except as otherwise provided in this Convention, paragraphs 1 and 2 shall not apply to quantities of a chemical to be used for laboratory-scale research or as a reference standard.

6. Any Party that has a specific exemption in accordance with Annex A or a specific exemption or an acceptable purpose in accordance with Annex B shall take appropriate measures to ensure that any production or use under such exemption or purpose is carried out in a manner that prevents or minimizes human exposure and release into the environment. For exempted uses or acceptable purposes that involve intentional release into the environment under conditions of normal use, such release shall be to the minimum extent necessary, taking into account any applicable standards and guidelines.

Article 5

Measures to reduce or eliminate releases from unintentional production

Each Party shall at a minimum take the following measures to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in Annex C, with the goal of their continuing minimization and, where feasible, ultimate elimination:

(a) Develop an action plan or, where appropriate, a regional or subregional action plan within two years of the date of entry into force of this Convention for it, and subsequently implement it as part of its implementation plan specified in Article 7, designed to identify, characterize and address the release of the chemicals listed in Annex C and to facilitate implementation of subparagraphs (b) to (e). The action plan shall include the following elements:

(i) An evaluation of current and projected releases, including the development and maintenance of source inventories and release estimates, taking into consideration the source categories identified in Annex C;

(ii) An evaluation of the efficacy of the laws and policies of the Party relating to the management of such releases;

(iii) Strategies to meet the obligations of this paragraph, taking into account the evaluations in (i) and (ii);

(iv) Steps to promote education and training with regard to, and awareness of, those strategies;

(v) A review every five years of those strategies and of their success in meeting the obligations of this paragraph; such reviews shall be included in reports submitted pursuant to Article 15;

(vi) A schedule for implementation of the action plan, including for the strategies and measures identified therein;

(b) Promote the application of available, feasible and practical measures that can expeditiously achieve a realistic and meaningful level of release reduction or source elimination;

(c) Promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of the chemicals listed in Annex C, taking into consideration the general guidance on prevention and release reduction measures in Annex C and guidelines to be adopted by decision of the Conference of the Parties;

(d) Promote and, in accordance with the implementation schedule of its action plan, require the use of best available techniques for new sources within source categories which a Party has identified as warranting such action in its action plan, with a particular initial focus on source categories identified in Part II of Annex C. In any case, the requirement to use best available techniques for new sources in the categories listed in Part II of that Annex shall be phased in as soon as practicable but no later than four years after the entry into force of the Convention for that Party. For the identified categories, Parties shall promote the use of best environmental practices. When applying best available techniques and best environmental practices, Parties should take into consideration the general guidance on prevention and release reduction measures in that Annex and guidelines on best available techniques and best environmental practices to be adopted by decision of the Conference of the Parties;

(e) Promote, in accordance with its action plan, the use of best available techniques and best environmental practices:

(i) For existing sources, within the source categories listed in Part II of Annex C and within source categories such as those in Part III of that Annex; and

(ii) For new sources, within source categories such as those listed in Part III of Annex C which a Party has not addressed under subparagraph (d).

When applying best available techniques and best environmental practices, Parties should take into consideration the general guidance on prevention and release reduction measures in Annex C and guidelines on best available techniques and best environmental practices to be adopted by decision of the Conference of the Parties;

(f) For the purposes of this paragraph and Annex C:

(i) "Best available techniques" means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for release limitations designed to prevent and, where that is not practicable, generally to reduce releases of chemicals listed in Part I of Annex C and their impact on the environment as a whole. In this regard:

(ii) "Techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(iii) "Available" techniques means those techniques that are accessible to the operator and that are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages; and

(iv) "Best" means most effective in achieving a high general level of protection of the environment as a whole;

(v) "Best environmental practices" means the application of the most appropriate combination of environmental control measures and strategies;

(vi) "New source" means any source of which the construction or substantial modification is commenced at least one year after the date of:

a. Entry into force of this Convention for the Party concerned; or

b. Entry into force for the Party concerned of an amendment to Annex C where the source becomes subject to the provisions of this Convention only by virtue of that amendment.

(g) Release limit values or performance standards may be used by a Party to fulfil its commitments for best available techniques under this paragraph.

Article 6

Measures to reduce or eliminate releases from stockpiles and wastes

1. In order to ensure that stockpiles consisting of or containing chemicals listed either in Annex A or Annex B and wastes, including products and articles upon becoming wastes, consisting of, containing or contaminated with a chemical listed in Annex A, B or C, are managed in a manner protective of human health and the environment, each Party shall:

   (a) Develop appropriate strategies for identifying:

      (i) Stockpiles consisting of or containing chemicals listed either in Annex A or Annex B; and

      (ii) Products and articles in use and wastes consisting of, containing or contaminated with a chemical listed in Annex A, B or C;

   (b) Identify, to the extent practicable, stockpiles consisting of or containing chemicals listed either in Annex A or Annex B on the basis of the strategies referred to in subparagraph (a);

   (c) Manage stockpiles, as appropriate, in a safe, efficient and environmentally sound manner. Stockpiles of chemicals listed either in Annex A or Annex B, after they are no longer allowed to be used according to any specific exemption specified in Annex A or any specific exemption or acceptable purpose specified in Annex B, except stockpiles which are allowed to be exported according to paragraph 2 of Article 3, shall be deemed to be waste and shall be managed in accordance with subparagraph (d);

   (d) Take appropriate measures so that such wastes, including products and articles upon becoming wastes, are:

      (i) Handled, collected, transported and stored in an environmentally sound manner;

      (ii) Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of persistent organic pollutants or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option or the persistent organic pollutant content is low, taking into account international rules, standards, and guidelines, including those that may be developed pursuant to paragraph 2, and relevant global and regional regimes governing the management of hazardous wastes;

      (iii) Not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants; and

      (iv) Not transported across international boundaries without taking into account relevant international rules, standards and guidelines;

(e) Endeavour to develop appropriate strategies for identifying sites contaminated by chemicals listed in Annex A, B or C; if remediation of those sites is undertaken it shall be performed in an environmentally sound manner.

2. The Conference of the Parties shall cooperate closely with the appropriate bodies of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal to, inter alia:

(a) Establish levels of destruction and irreversible transformation necessary to ensure that the characteristics of persistent organic pollutants as specified in paragraph 1 of Annex D are not exhibited;

(b) Determine what they consider to be the methods that constitute environmentally sound disposal referred to above; and

(c) Work to establish, as appropriate, the concentration levels of the chemicals listed in Annexes A, B and C in order to define the low persistent organic pollutant content referred to in paragraph 1 (d) (ii).

Annex A, part II

Polychlorinated biphenyls

Each Party shall:

(a) With regard to the elimination of the use of polychlorinated biphenyls in equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) by 2025, subject to review by the Conference of the Parties, take action in accordance with the following priorities:

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;

(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;

(iii) Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres;

(b) Consistent with the priorities in subparagraph (a), promote the following measures to reduce exposures and risk to control the use of polychlorinated biphenyls:

(i) Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimized and quickly remedied;

(ii) Not use in equipment in areas associated with the production or processing of food or feed;

(iii) When used in populated areas, including schools and hospitals, all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks;

(c) Notwithstanding paragraph 2 of Article 3, ensure that equipment containing polychlorinated biphenyls, as described in subparagraph (a), shall not be exported or imported except for the purpose of environmentally sound waste management;

(d) Except for maintenance and servicing operations, not allow recovery for the purpose of reuse in other equipment of liquids with polychlorinated biphenyls content above 0.005 per cent;

(e) Make determined efforts designed to lead to environmentally sound waste management of liquids containing polychlorinated biphenyls and equipment contaminated with polychlorinated biphenyls having a polychlorinated biphenyls content above 0.005 per cent, in accordance with paragraph 1 of Article 6, as soon as possible but no later than 2028, subject to review by the Conference of the Parties;

(f) In lieu of note (ii) in Part I of this Annex, endeavour to identify other articles containing more than 0.005 per cent polychlorinated biphenyls (e.g. cable-sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6;

(g) Provide a report every five years on progress in eliminating polychlorinated biphenyls and submit it to the Conference of the Parties pursuant to Article 15;

(h) The reports described in subparagraph (g) shall, as appropriate, be considered by the Conference of the Parties in its reviews relating to polychlorinated biphenyls. The Conference of the Parties shall review progress towards elimination of polychlorinated biphenyls at five-year intervals or other period, as appropriate, taking into account such reports.

Annex XII – List of contacts

International Civil Aviation Organization (ICAO)
Operations/Air Worthiness Section
International Civil Aviation Organization
999, University Street
Montreal
Quebec H3C 5H7
Canada
Tel. (1) 514 954 80 99
Fax (1) 514 954 67 59
E-mail: krooney@icao.int

International Air Transport Association (IATA)
800 Place Victoria
P.O. Box 113
Montreal
Quebec H4Z 1M1
Tel. (1) 514 390 6746/6766
Fax: (1) 514 874 2660
E-mail:abouchaarj@iata.org mccullochn@iata.org

International Maritime Organization
(Dangerous goods at sea)
International Maritime Organization (IMO)
4, Albert Embankment
London SE1 7SR
United Kingdom
Tel. (44) 20 75 873 160
Fax: (44) 20 75 873 210
E-mail: irahim@imo.org

Intergovernmental Organization for International Carriage by Rail (OTIF)
(Provisions of the Berne Convention)
Gryphenhübeliweg 30
CH – 3006
Berne
Switzerland
Tel. (41 31) 359 10 16/17/10
Fax: (41 31) 359 10 11
E-mail: otif@otif.org

International Road Transport Union (IRU) (ADR regulations, UN/ECE)
Centre International
3, rue de Varembé
C.P. 44
CH – 1211 Geneva 20
Switzerland
Tel. (41 22) 918 27 00
Fax: (41 22) 918 27 41
E-mail: soren.rasmussen@iru.org

Joint OCHA-UNEP Environment Unit
Palais des Nations, Door 2, 2nd floor
Geneva
Switzerland
Tel. (41 22) 917 11 72 /917 11 42
Fax: (41 22) 907 02 57
E-mail: vladimir.sakharov@dha.unicc.org

UNECE-Committee of Experts on the Transport of Dangerous Goods
Transport Division
Dangerous Goods and Special Cargoes Section
Palais des Nations
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Fax: (41 22) 917 00 39
E-mail: olivier.kervella@unece.org

Secretariat of the Rotterdam Convention
Secretariat at UNEP
UNEP Chemicals
11-13, chemin des Anémones
CH 1219 Châtelaine
Geneva - Switzerland
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Fax: (41 22) 797 34 60
E-mail: ssc@chemicals.unep.ch

Interim Secretariat of the Stockholm Convention on Persistent Organic Pollutants
11-13, Chemin des Anémones
CH-1219 Châtelaine
Geneva – Switzerland
Tel. (41 22) 917 81 91
Fax: (41 22) 797 34 60
E-mail: ssc@chemicals.unep.ch
Internet homepage: www.pops.int

United Nations Industrial Development Organization (UNIDO)
Vienna International Centre
A-1400 Vienna (Headquarters)
P.O. Box 300
Austria Tel. (43 1) 260 26
Fax: (43 1) 269 26 69
Zcsizer@unido.org

Secretariat of the Basel Convention on the Control of the Transboundary Movements of Hazardous Wastes and Their Disposal (UNEP/SBC)
International Environment House
Chemin des Anémones 15
1219 Châtelaine
Geneva
Switzerland
Tel. (41 22) 917 82 18
Fax: (41 22) 797 34 54
E-mail: sbc@unep.ch
Internet homepage: www.basel.int

Annex XIII – References

By chronological order of publication

Technical Working Group of the Basel Convention: "Draft technical guidelines on the environmentally sound management of POPs as wastes" 2002

Technical Working Group of the Basel Convention: "Draft technical guidelines on wastes comprising or containing PCBs, PCTs and PBBs", 2002 (Y10)

World Bank/UNEP Chemicals/DANCED: "'Draft guidance document for the preparation of national implementation plans for POPs", 2002

UNEP Chemicals: "PCB transformers and capacitors: From management to reclassification and final disposal", 2002

SBC/African Institute of Urban Management /Ministry of Environment and Amenities - Côte d'Ivoire: "Pilot project for the preparation of a national plan for the environmentally sound management of PCBs" 2002 (F only)

SBC/GTZ/NEA-Gambia: "Pilot project for the inventorying of PCB-containing equipment in the Gambia", 2002

SBC No: 01/01: "First African Conference on the prevention and environemntally sound management of hazardous waste stocks. Report and background documents", 2001

UNEP Chemicals: "Study of currently available technologies for the destruction of PCBs without incineration", 2000

UNEP Chemicals: "Guidelines for the identification of PCBs and PCB-containing equipment", 1999

World Bank Group: *Pollution Prevention and Abatement Handbook*, 1998

UNEP Chemicals: "Inventory of global PCB-destruction capacities", 1998

SBC No. 97/005: "Technical guidelines on incineration on land" (D10), January 1997

SBC No. 97/006: "Technical guidelines on used oil re-refining or other re-uses of previously used oil" (R9), January 1997

Basel Convention Highlights No. 96/001: "Guidance in developing national and/or regional strategies for the environmentally sound management of hazardous wastes", November 1997

See also the regulations, technical guidelines and national plans developed by a number of parties to the Basel Convention de Bâle and available on the internet:

http://www.environment.gov.za/
Department of Environmental Affairs and Tourism, South Africa

http://www.erin.gov.au
Environnement Australia

http://www.ec.gc.ca
Environnement Canada

http://europa.eu.int
European Commission

http://www.ine.gob.mx/
National Ecology Institute, Mexico

http://www.desechospeligrosos.org
Basel Convention Regional Coordinating Centre for Latin América and the Caribbean

http://www.epa.gov
Environmental Protection Agency, United States of America